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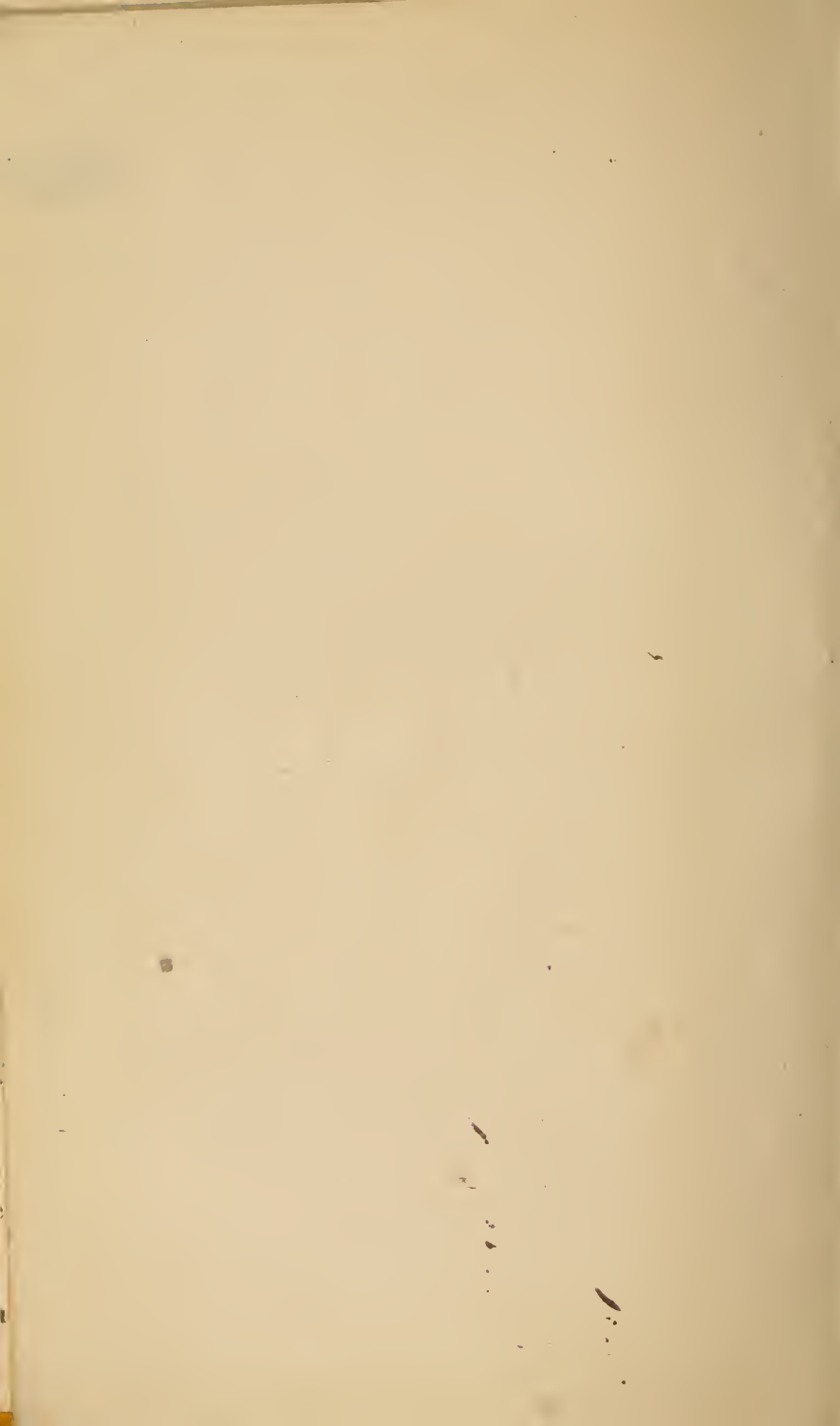
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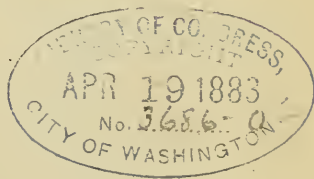
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# LITERATURE.

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1. Give a definition of *Literature*.

2. What was the origin of Literature?

Ans.—Egypt had her literature in the form of hieroglyphics (priestly writings). These characters—685 in number—were the germ of an alphabet and were in part phonetic. The *cuneiform*, wedge-shaped or arrow-headed characters of the Babylonians and Assyrians were not truly phonetic. “It was reserved for the Phoenicians to adopt the apparently simple, yet ingenious and beautiful, device of determining the few elementary sounds of language and appropriating one distinctive character to represent each sound.”

NOTE.—The Hindoos had a voluminous literature containing the three *Vedas*—supposed to have been written about 4,000 years ago—; the Persians, the *Zendervester* (or *Zend Avesta*) of Zoroaster and other writings. The Old Testament is an example of the Hebrew Literature.

Query.—What are the “Seven Bibles” of the world? What was the “Rosetta Stone”? Who was Firdousi?

3. What is the history of the alphabet?

Ans.—The Greeks derived their alphabet from the Phoenicians. The Romans adopted the Greek, and the Roman alphabet is the basis of our modern ones. Pliny states that “*Cadmus* brought sixteen letters from Phœ-

nicia into Greece, to which Palamedes, in the time of the Trojan war, added four more, and Simonides afterwards added four."

NOTE.—The origin of languages, like that of nations, is frequently lost in the darkness that shrouds primitive history. Modern scholars have proved that *Cadmus* is a mere fabled name signifying "the East." Still the transition from the Phœnician to the Greek may be readily seen by examining their alphabets.

#### 4. What were the first forms of literary art?

ANS.—The Greek Literature. The oldest poems (poetry preceded prose) are the epics of Homer,—880 B. C.,—the *Iliad* (from Ilium, the name of Troy,) and the *Odyssey*. The *Iliad* is a history of the Trojan war, and the *Odyssey* describes the adventures of Ulysses, King of Ithaca, after the fall of Troy.

NOTE.—Read Pope's or Bryant's translation.

Query.—Who was Penelope? What is an epic poem? What English scholars have written on the authorship of Homer? ANS.—Barnes, Gladstone, and Blackie. Professor Joshua Barnes, of the University of Cambridge, England, in the reign of Queen Anne, who edited Homer, Anacreon, and Euripedes, wrote a poem to prove that *Solomon* was the author of the *Iliad*. His object was to raise money to publish his Homer.

#### 5. What works constitute the "Bible of the Greeks"?

ANS.—The writings of Homer and Hesiod (who lived about 789 B. C.), because they put in writing the belief about the gods. The writings of Hesiod are the "*Theogony*" and "*Works and Days*."

Query.—When was the "Legendary Age"?

#### 6. What writers were of later origin?



Ans.—Tyrtæus—a lame school-master at Athens (720 B. C.) wrote *elegies*—whose stirring songs had a great influence in the Messenian war. Also Simonides of Ceos, Sappho, Alcæus, Anacreon, and Pindar (522 B. C.) are the most famous names in *lyric* poetry. The *drama*, during the age of Pericles (469-399 B. C.), was distinguished by such names as Aeschylus, Sophocles, and Euripedes, in tragedy, and Aristophanes, Phrynicus, and Menander, in comedy.

NOTE.—The writings of Euripedes are *Hecuba*, *Orestes*, *Medea*, *Alcestis*, *Bacchæ*, *Ion*, *Andromache*, *Suppliants*, *Iphigenia in Taurus*, *Hercules Furens*, *Cyclops*, etc., etc. Those of Aristophanes are *Achamians*, *Knights*, *Clouds*, *Wasps*, *Frogs*, *Peace* and *Birds*, *Lysistrata*, etc. Aeschylus was killed by the descent of a tortoise, which an eagle let fall on his bald pate, mistaking it for a rock.

Query.—What is the fable of Cymon and Iphigenia?

## 7. Who was Herodotus?

Ans.—The celebrated Greek historian, styled “The Father of History,” born in Halicarnassus, Asia Minor, about 484 B. C., and is supposed to have died in Thurii, Italy, about 420 B. C. He is said to have been exiled from Halicarnassus by the tyrant Lygdamis, and travelled in Greece, Africa, Asia, and Europe, noting the manners and customs of the people whom he visited, the scenery, cities, temples, etc. He returned to Halicarnassus about 455, and assisted in expelling Lygdamis. He removed soon after to Athens, and occupied himself with the composition of his great work, which is comprised in nine books. Its principal subject is the internal struggles of the Greeks, but he has introduced narratives of the histories of the Persians, Medes, Egyptians, and other peoples. He is considered the most reliable of all ancient historians, the only drawback being his undue love for the marvelous. When

he writes from his own observation, he is truthful and accurate. His style is elegant and harmonious, and his book is prized as a rare composition as well as a history.

NOTE.—Information in regard to Egypt was, until the present century, derived chiefly from Herodotus, from some fragments of a history written in Greek by Manetho, an Egyptian priest, in the third century, B. C., and from the writings of Diodorus Siculus, who lived in the first century.

Query.—What were the results of the excavations of Dr. Schliemann (1839-73) on the site of Troy?

## 8. Name the other Grecian Historians.

Ans.—Thucydides, (born 471 B. C.); Xenophon, (born 441 B. C.); Polybius, (born second century B. C.), and Plutarch, (second century A. D.)

NOTE.—Thucydides wrote the *Peloponnesian War*. Xenophon, the *Anabasis*, *Memorabilia*, *Cyropædia* (education of Cyrus), *Hellenics*, and minor works. Plutarch's "*Lives*" are called the *Bible of Heroisms*.

Query.—What is the origin of the expression "He's a brick"?  
 Ans.—Very few of the thousands who use this slang term know its origin or its primitive significance, according to which it is a grand thing to say of a man, "He is a brick!" The word used in its original intent implies all that is brave, patriotic, and loyal. Plutarch in his life of Agesilaus, King of Sparta, gives us the meaning of the quaint and familiar expression: On a certain occasion an ambassador from Epirus, on a diplomatic mission, was shown by the king over his capital. The ambassador knew of the monarch's fame—knew that, though nominally only king of Sparta, he was ruler of Greece—and he had looked to see massive walls rearing aloft their embattled towers for the defence of the city, but he found nothing of the kind.

He marvelled much at this, and spoke of it to the king. "Sire," he said, "I have visited most of the principal towns, and I find no walls reared for defence. Why is this?" "Indeed, Sir Ambassador," replied Agesilaus, "thou can'st not have looked carefully. Come with me to-morrow morning and I will show you the walls of Sparta." Accordingly, on the following morning, the king led

his guest out upon the plain where his army was drawn up in full array, and, pointing proudly to the patriot host, he said, "There thou beholdest the walls of Sparta—ten thousand men, and every man a brick."

## 9. Who were the Grecian philosophers?

Ans.—Thales, who lived in the sixth century B. C., the founder of the Ionic school; Pythagoras, who belonged to the same century, and established the Pythagorean school; Socrates, (469–399 B. C.) who did not teach any especial system of philosophy, but was engaged in breaking down prejudices and exposing fallacies; Plato, (429–347 B. C.) the founder of the Academic school, and Aristotle (384–322 B. C.) the originator of the Peripatetic school, in the Lyceum at Athens.

*Query.*—Who were the "Seven Wise Men"? Who established the *deductive* system of reasoning? Who is the "father" of the *inductive* system?

## 10. By whom was oratory practiced?

Ans.—Solon, Pisistratus, Miltiades, Aristides, Themistocles, Protagoras, Pericles, Aeschines, and Demosthenes.

NOTE.—The teachings of her philosophers, and the orations of her statesmen form a prominent feature in the literature of Greece. Plato's works remain in the form of his "*Dialogues*." Demosthenes' "*Orations*" are published in five volumes.

*Query.*—What was the "Phillipic"? How was Demosthenes cured of stammering?

## 11. What are the four fine arts?

Ans.—Architecture, Sculpture, Painting, and Music. The three classic forms of architecture are the DORIC, the IONIC, and the CORINTHIAN. Sculpture and painting were highly cultivated among the Greeks, the former by



Phidias and Praxitiles; the latter by Parrhasius, Zeuxis, and Appelles.

NOTE.—Pliny's anecdote of the contest between Parrhasius and Zeuxis will serve to illustrate the excellence to which these artists had attained. Zeuxis painted a cluster of grapes. Upon their exhibition, the birds were deceived, and flew at them as if they were real; whereupon the painter boasted of his success. His rival, Parrhasius, not to be outdone, determined to deceive Zeuxis himself. One day he introduced the painter of the grapes to his studio, where was the picture which was to excel what Zeuxis had done. "Draw aside the curtain," said Zeuxis, "that we may see the painting." The curtain itself was the picture, and the painter of it was declared the greatest, because he had deceived the man who had deceived the birds.

Query.—What is *lyric* poetry? What are some of the departments of literature for which Greece was famous? Name some prominent writer in each department.

12. When was the beginning of Roman literature?

ANS.—The early history of Rome is given in an unbroken narrative by the Roman writers, but these romantic legends can no longer be regarded as real. The records of the early days of Rome are known to have been destroyed when the city was burned by the Gauls (390 B. C.); and LIVY, the *earliest* writer on Roman affairs whose works have come down to us, wrote 750 years after the foundation of the city, or about the time of the Christian era. About the commencement of the second century before Christ, we have the *beginning* of that Latin literature which we still read. ENNIUS was the father of Roman poetry; PLAUTUS, his contemporary, was a man of rich poetic genius; the elder CATO was the first prose writer of note; while TERENCE was the most famous of the comic poets.

13. What was the "Golden Age" of literature?

ANS.—The Reign of Augustus, 27 B. C. to 14 A. D. HORACE, VIRGIL, and all the most celebrated Latin poets and scholars were his friends. Among these were OVID, author of the *Metamorphoses*, *Heroides*, *Art of Love*, etc.; CORNELIUS NEPOS, the biographer; TITUS LIVIUS (*Livy*), the great historian of Rome; and SALLUST, the historian of the Jugurthine War and the conspiracy of Catiline.

NOTE.—Among other distinguished writers of this age or the times immediately preceding it are LUCRETIUS; CATULLUS, "author of lyrics that are among the sweetest and most poetic things in the Latin language"; MARTIAL, the writer of epigrams; PLINY, the writer on natural history (killed, 79 A. D., by the great eruption from Vesuvius, which buried the cities of Pompeii and Herculaneum); JUVENAL, the satirist; and TACITUS, the historian, during the "last days of Rome."

#### 14. What is the *AENEID*?

ANS.—An epic poem by VIRGIL, author of the *Georgics*, *Bucolics* etc., which relates the story of Aeneas, a Trojan hero, who flees from burning Troy (see Homer's *Iliad*), and, after years of wandering, lands in Italy and founds a city.

NOTE.—HORACE, who was a witty and vivacious song-writer, is the author of many poems, odes, satires, and epistles.

TACITUS wrote *The Annals*, *The History*, *The Germania*, and *Agricola*.

Query.—Wherein does *Poetry* differ from *Prose*? What are the chief departments of Roman literature? Name a prominent author in each *department*.

#### 15. Before the "*Dark Ages*" what books were written?

ANS.—Following the decline of Rome were the "*Dark Ages*"—extending from the fifth to the fifteenth century—which were unproductive of real literature, but immedi-

ately preceding them there arose a set of theological writers both in Greek and Latin, who are known collectively as the "*Christian Fathers*." Among the most famous of these are:—

TERTULLIAN, born at Carthage 160, who was the first of the Latin writers of the church. His chief work "*Apolo-  
gy for Christians*," was written about 198.

ORIGEN, born in Egypt 185, was the editor and commentator of the Scriptures and wrote in Greek.

CYPRIAN, who was Archbishop of Carthage in the middle of the third century, wrote "*Unity of the Church*," and suffered martyrdom under Valerian.

AMBROSE, born 340 in Gaul, was Archbishop of Milan. His chief work is "*De Officiis*."

ATHANASIUS, born in Alexandria, end of the third century.

GREGORY NAZIANZEN, born early in the fourth century in Cappadocia,—for a while Patriarch of Constantinople—noted as a writer of theology and religious poetry.

JEROME, born in 340 in Dalmatia. He was especially learned in Hebrew, was the founder of monasticism, and his chief work is a translation of the Bible into Latin (known as the "*Vulgate*," a version for the common people:—from *vulgus*.)

AUGUSTINE, born in Numidia, in Africa, 354. He was Bishop of Hippo in Africa, was called the father of Latin Theology and his chief works are "*On the Grace of Christ*," "*Original Sin*," "*City of God*," and "*Confessions*," (an autobiography).

CHRYSTOSTOM, (Gold-mouth, from his eloquence), was born the same year at Antioch. Like Gregory he was also Patriarch of Constantinople. His works are written in Greek.

NOTE.—These dates are all A. D.



## 16. When was the "Revival of Learning"?

Ans.—A new literature began to spring up in French, Spanish, Italian, and German about the time of the crusades (1096-1192). The first language to develop a new literature was the *Romance* of Southern France. The romance languages are the French, Spanish, and Italian. While Europe however was sunk in the grossest ignorance, the Saracens were actively engaged in the cultivation of science, learning, and the arts. "The schools of Cordova vied with those of Bagdad in the collection of books and the encouragement of science, and from them proceeded nearly all that was original in the medicine, physics, and metaphysics of Europe during the middle ages."

NOTE.—Even Charlemagne (742-814) was a great patron of learning and learned men. Fond of literary pursuits, he pursued the whole range of mental science. The Middle Ages were not as *dark* as the name indicates.

Query.—What are *palimpsests*? Who were the "Venerable Bede" and Alcuin?

## 17. What Universities were founded?

Ans.—The University of Oxford in England is said to have been founded by King Alfred (ninth century), but it was not a flourishing seat of learning till the eleventh century. In the year 1201, it contained 3,000 scholars. The University of Paris became famous at the beginning of the twelfth century, under the teachings of ABELARD. The University of Bologna had a roll of 1,000 students in the twelfth century; while the University of Paris, in the fifteenth century, numbered 25,000 students. Cambridge was founded in the thirteenth century. The earliest German university was that of Prague, established in 1350.

NOTE.—In the eleventh and twelfth centuries was the rise of the new "scholastic philosophy," the chief feature of which was

the application of the art of dialectics to subtle questions of metaphysics and theology, made famous by such Schoolmen as Aquinas, Scotus, Roscelin, Anselm, and Peter Lombard. One of the questions discussed with great interest was "How many angels can stand on the point of a needle?"

### 18. Who were Roger Bacon and Albertus Magnus?

Ans.—Bacon was an English monk who with Magnus began to investigate mathematical and scientific questions, in the thirteenth century. They made wonderful advances in true knowledge, but each had to pay the penalty of being in advance of his age, for they were both punished as magicians.

### 19. When was the beginning of Modern Literature?

Ans.—A *native* literature had begun to spring up in the thirteenth and fourteenth centuries. The principal specimens are the German collection known as the *Nibelungen Lied*, the Spanish romance of the *Cid*, and the cycle of poetry relating to the British Arthur and his Knights of the Round Table. The real beginnings of our modern literature are the works of DANTE, 1265–1321, and CHAUCER, 1328–1400.

NOTE.—Read Longfellow's translation of Dante's *Divina Commedia* (Divine Comedy). The first period of the literary history of Italy also includes the names of *Petrarch*, 1304–1374, the lyric poet; and *Boccaccio*, 1313–1375, author of the "*Decameron*," in prose. *Chaucer* visited Italy, is supposed to have seen Petrarch, and was at least much influenced by the literature of that country.

### 20. What are Chaucer's works?

Ans.—The principal one is the *Canterbury Tales*. It is

a collection of admirable daguerreotypes of the various classes of English society, and consists of twenty-four stories supposed to have been told by a company of pilgrims on their way to Canterbury. The others are the *Romaunt of the Rose*, *Court of Love*, *Chaucer's Dream*, *Boke of the Duchesse*, *Legend of Good Women*, etc.

Extract:—

“ And the rivere that I sat upon,  
It made such a noise as it ron,  
Accordaunt with the birdes armony,  
Methought it was the beste melody  
That mighte ben yheard of any man.”

*Cuckow and the Nightingale.*

NOTE.—The works produced in England from 450 to 1050 were in *Anglo Saxon*, now a dead language; *Semi-Saxon*, from 1150 to 1250; *Old English*, from 1250 to 1350; *Middle English*, from 1350 to 1550; and *Modern English*, from 1550 to the present day. The first three divisions have quite a voluminous literature, well worthy the study of the devoted student.

Query.—Who was called the “Morning Star of the Reformation”?

21. What are the nine periods of English literature?

Ans.—I. The Age of Chaucer, 1350–1400.

II. The Age of Caxton, 1400–1550.

III. The Elizabethan Age, 1550–1625.

IV. The Age of Milton, 1625–1660.

V. The Age of the Restoration, 1660–1700.

VI. The Age of Queen Anne, 1700–1750.

VII. The Age of Johnson, 1750–1800.

VIII. The Age of Scott, 1800–1830.

IX. The Victorian Age, 1830–1882.

22. Name other writers of Chaucer's age.

ANS.—(1) William Langland (1332-1400), *Piers the Plowman*. (2) John Gower—"Moral Gower," Chaucer calls him—(1320-1408) was the author of three great works, *Speculum Meditantis*, in Norman French; *Vox Clamantis*, in Latin; and *Confessio Amantis* (A Lover's Confession), in English. *English Prose Literature* begins with (3) Sir John Mandeville (1300-1371), author of a book of Travels. (4) John Barbour (1316-1396) was the great *Scottish poet* of this age.

### 23. Who were the writers of Caxton's age?

ANS.—William Dunbar (1465-1520), *The Dance of the Seven Deadly Sins*. James I. (1394-1437), wrote a collection of love verses under the title of the *King's Quhair*. (i. e. *Quire* or *Book*). John Skelton (1460-1529), *Colin Clout*, etc. Sir Thomas Moore (1503-1542), author of *Utopia*, a philosophical romance, written in Latin. Wyatt, Blind Harry, Surrey, Tyndale and Coverdale.

### 24. What was the Elizabethan age?

ANS.—The most glorious era of English literature. It is renowned for its three writers—Spenser, Shakespeare\* and Bacon—either of whom would have made an age illustrious. The first name is that of George Gascoigne (1530-1577) one of the founders of the great English school of the drama, "*Steel Glass*," "*Fruits of War*." Thomas Sackville (1536-1608), "*A Mirrour for Magistrates*." Edmund Spenser (1533-1599) "*The Faerie Queen*," "*Shepherd's Calendar*" (a series of pastorals similar to Virgil's *Bucolics*), and "*Mother Hubbard's Tale*."

### 25. Who has been called the "myriad-minded"?

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\*Most Shaksperian scholars now spell the name *Shakspeare*.



Ans.—William Shakespeare, the greatest dramatist, and probably the greatest genius of all time, (1564-1616). His dramas are thirty-seven in number. *Othello*, *Lear*, and *Hamlet* are distinctly tragedies. *As You Like It*, *Merry Wives of Windsor*, *Taming of the Shrew* and *Twelfth Night* are comedies, while the rest are termed *Historical Plays*. *Venus and Adonis*, “the first heir of his invention,” was published in 1593.

Extracts:—“*Sweet are the uses of adversity.*”—“*As You Like It*,” Act I, Sc. 3.—DUKE.

“We are such stuff as dreams are made of.”—“*Tempest*,” Act IV, Sc. 1.—PROSPERO.

“Misery acquaints a man with strange bed-fellows.”—“*Tempest*,” Act II, Sc. 2.—TRIN.

“And the imperial vot’ress passed on  
*In maiden meditation, fancy free.*”

“*Midsummer Night’s Dream.*” Act II, Sc. 1. OBERON.

“I’ll put up a girdle round the earth in forty minutes.”  
Same as above.—PUCK.

“Then must you speak of one that *lov’d not wisely, but too well.*”—“*Othello*,” Act V, Sc. 2.

26. Who was the author of the “*Novum Organum*”?

Ans.—Sir Francis Bacon, known as Lord Bacon, (1561-1626). This was the second part of his *Instauratio Magna*, a work to consist of six books, three of which only were finished, a brief extract being given of the fourth. His *Essays* are the most popular.

Selections:—“Knowledge is power.” “A little philosophy inclineth a man’s mind to atheism, but depth in philosophy bringeth men’s minds about to religion.” Compare

this with Pope's, "A little knowledge is a dangerous thing."

27. Who were the dramatic poets of this age?

ANS.—Christopher Marlowe (1564–1593), "*Tamburlane*," and "*Faustus*." Rare Ben Jonson (1573–1637), second to Shakespeare only, "*Every Man Out of his Humor*," "*Alchemist*," "*Catiline*," "*Epicene, or the Silent Woman*," "*Fall of Sejanus*," "*Tale of a Tub*," "*Masques*," etc. Beaumont (1586–1615) and Fletcher (1576–1625), "who worked together with so intimate a union that it is impossible, in the works composed before their friendship was dissolved by death, to separate their contributions," were the authors of "*Maid's Tragedy*," "*A King and No King*," "*Laws of Candy*," "*Beggar's Bush*," "*Rule a Wife and Have a Wife*," "*Spanish Curate*," etc.

Philip Massinger (1584–1640), "*Fatal Dowry*," "*Roman Actor*," "*Maid of Honor*," "*Unnatural Combat*," "*New Way to Pay Old Debts*," etc.

John Ford (1586–1639), "*Witch of Edmonton*," "*Lover's Melancholy*," "*Love's Sacrifice*," etc.

John Webster, "*Duchess of Malfy*," "*Guise, or the Massacre of France*," "*White Devil*," etc.

NOTE.—To this bright galaxy of names may be added Chapman, Dekker, Middleton, Marston, Taylor, Tourneur, Broome, Heywood, and Shirley.

Query.—Who wrote "*A Woman Killed with Kindness*"? Who was Sir Philip Sidney? What courtier, soldier, adventurer, and writer, is the author of a *History of the World* (written in prison)? Who was the "well-languaged Daniel"? "Holy George Herbert" wrote what? Roger Ascham (1515–1568) was tutor to Princess (Queen) Elizabeth; what are his works?

28. What other great writers were there in the sixteenth century?

Ans.—In Italy, the historians Guicciardini (1482–1540); Machiavelli (1469–1527); the poets Ariosto (1474–1533), author of "*Orlando Furioso*"; Vittorio Colonna (1490–1547); and Tasso, who celebrated the First Crusade in his "*Jerusalem Delivered*." Cervantes (1547–1616) was a renowned Spanish writer. His immortal work is "*Don Quixote*." Rabelais (1483–1533), a famous French satirist, was a priest, and wrote a book called the "*Life of Gargantua and Pantagruel*." Montaigne (1533–1592) was a judge and mayor of Bordeaux, the author of "*Essays*." Camoens (1524–1579), a Portuguese poet, is known principally from his great work called the "*Lusiad*," which celebrates the chief actors in, and events of, the history of Portugal.

Query.—Who were Michael Angelo, Raphael, Titian, Durer, Holbein, Copernicus, Galileo, and Tycho-Brahe?

### 29. Who is the author of "*Paradise Lost*"?

Ans.—John Milton (1608–1674). His principal poetic works are "*Paradise Regained*," "*Comus*," "*Lycidas*," "*L' Allegro*" and "*Il Penseroso*." His prose writings are too numerous to mention. The writers of his age are the so-called metaphysical poets, and theologians.

Query.—Who was Izaak Walton? What are the works of Jeremy Taylor? Who is the author of "*Religio Medici*," (Religion of a Physician)?

### 30. Who is the greatest author of the "Restoration Age"?

Ans.—John Dryden (1631–1700), who wrote dramas, poems, and essays, "*Duke of Guise*," "*Wild Gallant*," "*Rival Ladies*," "*Hind and Panther*," "*Ode on St. Cecilia's Day*," "*All for Love*," and a "*Translation of Virgil's Aeneid*."

## Selections.—

"Men are but children of a larger growth."

"Great wits are sure to madness near allied,  
And thin partitions do their bounds divide."

"Three poets in three distant ages born,  
Greece, Italy and England did adorn."

Query.—What three poets?

NOTE.—Samuel Butler (1612-1680) is the most illustrious literary representative of the Cavaliers. His great work is the burlesque satire of "*Hudibras*." A large mass of Butler's miscellaneous writings have been published.

### 31. Who were the contemporaries of Dryden?

ANS.—Locke, Newton, Boyle, Temple, Evelyn, Bunyan, L'Estrange, and Samuel Pepys (1632-1703), the author of a "*Diary*," which is a complete scandalous chronicle of a society so gay and debauched that the simple description of what took place is equal to the most dramatic picture of the novelist.

NOTE.—There is a strong contrast between the drama of Elizabeth and that of the Restoration, and the latter part of the seventeenth century produced a constellation of splendid dramatists, Sir George Etherege wrote the "*Man of Mode or Sir Fopling Flutter*"; William Wycherley, "*Love in a Wood*," "*Country Wife*," etc.; Sir John Vanbrugh, "*Provoked Wife*," "*Aesop*," and "*Relapse*"; George Farquhar, "*Love and a Bottle*," "*Twin Rivals*," "*Stage Coach*," and "*Beaux' Stratagem*."

William Congreve, who stands at the head of comic dramatists, wrote "*Old Bachelor*," "*Double Dealer*," "*Love for Love*," (his master-piece), "*Mourning Bride*," and "*Way of the World*"; Thomas Otway, "*Orphan*," and "*Venice Preserved*"; Nathaniel Lee (died 1692), "*Theodosius*," "*Mithridates*," and "*Lucius Junius Brutus*"; Thomas Southerne, "*Isabella, or the Fatal Marriage*," and the pathetic drama of "*Oroonoko*"; Nicholas Rowe, "*Jane Shore*," "*Fair Penitent*" and "*Lady Jane Gray*"; George Lillo, "*George Barnwell*" and "*Fatal Curiosity*."



32. What other *great names* in the literature of the seventeenth century?

Ans.—Calderon (1601-1681), a distinguished Spanish dramatist wrote about five hundred pieces. La Fontaine (1621-1705), a French poet, wrote "*Fables*." Moliere (1632-1673), a French dramatist, wrote many charming comedies, such as "*Le Bourgeois Gentilhomme*," (a text-book at Harvard), "*Le Misanthrope*," and "*Tartufe*." Boileau (1636-1711), a noted French poet, was remarkable for the moral tone of his writings, viz., "*Satires*," "*Epistles*," and "*Lutrin*." Racine (1639-1699), the most celebrated of the French dramatists, wrote "*Andromaque*," "*Phedre*," and "*Iphigenie*." Fenelon (1651-1715), a French author whose best known work is the romance of "*Telemaque*." Corneille (1605-1684), born at Rouen, wrote the great tragedy of the "*Cid*," and "*Horace*" and "*Cinna*."

Query.—Who were Vandyck, Rembrandt, Murillo, Rubens, Pascal, and Bossuet?

33. Who were the literary representatives of Queen Anne's age?

Ans.—Pope, Addison, and Swift. Alexander Pope (1688-1744) wrote "*The Rape of the Lock*," a translation of the Iliad and Odyssey, "*Elegy on an Unfortunate Lady*," "*Epistle from Sappho to Phaon*," "*Dunciad*," "*Ode on St. Cecilia's Day*," (see Dryden), etc.

Selections:—"To err is human; to forgive divine," (Essay on Criticism). "Vice is a monster of so frightful mien, etc." (Essay on Man). "I lisped in numbers, for the numbers came."

Joseph Addison (1672-1719), wrote the "*Tragedy of Cato*," "*Tatler*," "*Spectator*," "*Travels in Italy*,"

"*The Campaign*," and "*Guardian*." Jonathan Swift (1667-1745), is the author of "*Gulliver's Travels*," "*The Tale of a Tub*," "*Journal to Stella*," and innumerable pamphlets.

NOTE.—This was called the *Augustan* age of English literature. The other writers of this period were William Collins, a fine lyric poet, author of "*Ode to the Passions*," "*How Sleep the Brave*"; Matthew Prior, who wrote "*Alma*," "*Solomon*," "*Country Mouse and City Mouse*"; John Gay, "*Trivia, or the Art of Walking the Streets of London*," "*Three Hours after Marriage*," and "*Beggar's Opera*"; Edward Young, "*Love of Fame, the Universal Passion*," "*Night Thoughts*"; Sir Edward Steele, one of the writers for *The Tatler* and *The Spectator*; Allan Ramsey, "*Pastor Fido*," "*Galatea*"; Lady Mary Montagu, "*Letters*"; Daniel Defoe, "*Robinson Crusoe*," "*Adventures of Captain Jack*," "*Moll Flanders*," etc; James Thomson, "*Castle of Indolence*" and the "*Seasons*"; Garth, Parnell, Doddridge, Tickell, etc.

Query.—Which preceded the other in point of time, Dryden or Pope? Name the leading work of each. Who were the contemporaries of Shakespeare? Who is called the father of the modern novel? Ans. Defoe. What is the character of Addison's style? From what great writer is English literature generally supposed to date its origin?

34. Who was Oliver Goldsmith (1728\*-1774)?

Ans.—He was an Irishman, full of oddities and eccentricities, and remarkable alike for his strength and his weakness. Johnson said of him that "he wrote like an angel, but talked like poor Poll." His principal poems are "*The Traveller*," and "*Deserted Village*." "*The Vicar of Wakefield*" (a novel), "*She stoops to Conquer*" (a comedy), a "*Life of Beau Nash*," "*Chinese Letters*," "*Good-Natured Man*," and various "*Histories*" comprise the remainder of his works.

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\*His epitaph by Dr. Johnson says Nov. 29th, 1731. Other accounts state that he was born in 1729.

## Selections:—

"Then pilgrim turn, thy cares forego,  
All earth-born cares are wrong;  
Man wants but little here below,  
Nor wants that little long."

"Sweet Auburn! loveliest village of the plain,  
Where health and plenty cheer'd the labouring swain," etc.

"When lovely woman stoops to folly,  
And finds too late that men betray," etc.

### 35. Name other authors of the Johnsonian Age.

Ans.—Thomas Gray (1716-1771), "*Elegy Written in a Country Churchyard*," Odes "*On the Spring*," "*On the Death of a Favorite Cat*," "*On a Distant Prospect of Eton College*," "*The Bard*," and "*To Adversity*."

Robert Burns (1759-1796), "*Highland Mary*," "*Auld Lang Syne*," "*The Cotter's Saturday Night*," "*Tam O'Shanter*," "*To a Mountain Daisy*," "*Bonny Doon*," "*Ye Banks and Braes*," "*Man was Made to Mourn*," "*Scotch Drink*," etc.

## Selections:—

"Had we never loved sae kindly,  
Had we never loved sae blindly,  
Never met or never parted,  
We had ne'er been broken-hearted."

"Fare thee weel, thou first and fairest!  
Fare thee weel, thou best and dearest," etc.

"Oh wad some power the giftie gie us  
To see oursels as ithers see us!"

William Cowper (1731-1800), "*John Gilpin*," "*On Receiving my Mother's Picture*," "*The Castaway*," "*Hymns*," and "*The Task*," (a long poem in six books).

Samuel Johnson (1709-1784), who was at the head of

English writers of this age. His principal poems are "*London*," "*The Vanity of Human Wishes*," and his tragedy of "*Irena*." In prose, he wrote "*Rasselas*" (a romance), "*The Rambler*," "*Lives of the Poets*," and "*Dictionary of the English Language*." His biography was written by James Boswell (1740-1795).

Edmund Burke (1730-1797), the great orator, is the author of "*An Essay on the Sublime and Beautiful*," "*Reflections on the French Revolution*," etc. ("There is, however, a limit at which forbearance ceases to be a virtue.")

Laurence Sterne (1713-1768), an irreligious parson, author of "*Tristram Shandy*" and "*Sentimental Journey*."

NOTE.—Additionally, were Samuel Richardson, "*Pamela*," "*Clarissa*," and "*Sir Charles Grandison*"; Henry Fielding, "*Joseph Andrews*," "*The Life of Jonathan Wild the Great*," "*Tom Jones*," and "*Amelia*"; Tobias George Smollett, "*Roderick Random*," "*Peregrine Pickle*," "*The Adventures of Ferdinand, Count Falkom*," and a translation of "*Don Quixote*"; David Hume (1711-1776), the infidel philosopher, author of a "*History of England*" and a "*Treatise on Human Nature*"; Edward Gibbon (1737-1794), "*Study of Literature*," and "*History of the Decline and Fall of the Roman Empire*"; Sir Philip Francis, supposed author of the unsolved political mystery, the "*Letters of Junius*"; Richard Brinsley Sheridan, (1751-1816) said by Byron to have made the best speech—that on the BEGUMS OF OUDE—, written the two best comedies, the "*Rivals*" and the "*School for Scandal*"—, the best opera, the "*Duenna*"— and the best farce, the "*Critic*"; John Wolcot, David Garrick, Samuel Foote, Cumberland, Walpole, Paley, Reid, and Hannah More ("*Coelebs in Search of a Wife*.")

Query.—Can you regard Burns as an illustration of the adage, *Poeta nascitur, non fit* (Poets are born, not made)? Why? From what author is it quoted? What is meant by the statement, "Goldsmith was an intensely subjective poet"? What is meant by the Shakespearian-Bacon controversy? What extracts can you give from *Hamlet*, *Macbeth*, *King Lear*, *Merchant of Venice*, and *Richard III*?

36. What were the literary impostures of the eighteenth century?



Ans.—The poetical forgeries of Macpherson, Chatterton, and Ireland.

James Macpherson (1738-1796) pretended to have accumulated in his travels through the Highlands of Scotland an immense mass of fragments of ancient poetry composed in the Gaelic or Erse dialect common to that country and Ireland, which he published under the title of their reputed author, "*Ossian*." Thomas Chatterton (1752-1770), the "*marvelous boy*," deceived nearly all the scholars of his age by his imitations of Old English poetry. William Henry Ireland (1777-1835) indulged in Shakespearian forgeries, among which was a play entitled "*Vortigern*," in which John Kemble acted in 1795.

Query.—Can you give the birth-place of Dryden? of Shakspeare? of Milton? of Chaucer? of Sterne? of Cowper?

By what authors were these selections written?—

"Man's inhumanity to man makes countless thousands mourn."

"O, consistency, thou art a jewel!"

"The only amaranthine flower on earth is virtue."

"Fool's rush in where angels fear to tread."

"All is not gold that glitters." Ans. "*All that glistens is not gold*," Shakspeare;

"*But all things which that shineth as the gold,  
Ne is no gold, as I have heard it told*," Chaucer;

"*Yet gold all is not that doth golden seem*," Spenser; "*All, as they say, that glitters is not gold*," Dryden; and by Gray, Middleton, and others.

### 37. What was the Age of Romantic Poetry?

Ans.—This name is frequently applied to the Age of Scott. The authors of this age were George Gordon Noel Byron (1788-1824), who wrote "*Childe Harold*," "*The Dream*," "*The Prisoner of Chillon*," "*Mazeppa*," "*The*

*Bride of Abydos," "The Giaour," "Cain," "Manfred,"*  
and "*Don Juan*."

Extract from "*Mazeppa*":—

"For time at last set all things even;  
And if we do but watch the hour,  
There never yet was human power  
That could evade, if unforgiven,  
The patient search and vigil long,  
Of him who treasures up a wrong."

Thomas Campbell (1777-1844), "*Gertrude of Wyoming*,"  
"*Hohenlinden*," "*Lochiel's Warning*," "*O'Connor's Child*."

Extract from "*Pleasures of Hope*":—

"'Tis distance lends enchantment to the view,  
And robes the mountain in its azure hue."

John Keats (1795-1821), "*Endymion*," "*The Eve of St. Agnes*," "*Hyperion*," etc.

### 38. Who were the "Lake Poets"?

ANS.—"Lake Poets" is a nickname given by the British "to a certain brotherhood of poets, who haunted for some years about the lakes of Cumberland," and who were erroneously thought to have united to some settled theory of composition and style. Wm. Wordsworth (1770-1850), who wrote the "*Excursion*," the "*Prelude*" and several other poems noted for beautiful references to natural scenery and nature generally; Samuel Taylor Coleridge (1772-1834), the philosophic poet and critic, whose life was made miserable by the use of opium, author of "*Lectures on Shakespeare*," "*Christabel*," and "*Rime of the Ancient Mariner*"; and Robert Southey (1774-1843), writer of "*Thalaba*," "*Joan of Arc*," "*The Curse of Kehama*," etc., were regarded as the chief representatives of this so called school; but Lamb, Lloyd, and Wilson were also included under the same name.

NOTE.—The other writers of this age were Tom Moore, "*Lalla*

*Rookh*," "Loves of the Angels," "Anacreon," "Irish Melodies," "Veiled Prophet," "The Last Rose of Summer," etc.; Percy Bysshe Shelley, "Queen Mab," "Prometheus Unbound," "Cenci," "Adonais," "Rosalind and Helen," "The Skylark," etc.; Leigh Hunt, "Story of Rimini," "Captain Sword and Captain Pen," "A Legend of Florence"; Walter Savage Landor, "Conversations," "The Hellenics," "The Last Fruit of an Old Tree"; Thomas Hood, "The Bridge of Sighs," "Eugene Aram," "Song of the Shirt"; Charles Lamb, "Essays of Elia," "Farewell to Tobacco," "The Child Angel," "Rosamond Gray"; Thomas De Quincey, "Confessions of an English Opium Eater," "Flight of the Kalmuck Tartars"; Mrs. Hemans, "Lays, Lyrics, etc.," "The Graves of a Household"; Bryan Waller Proctor (Barry Cornwall), "Mirandola," "English Songs," etc.; and Samuel Rogers, L. E. Landon, Joanna Baillie, Pollok, Hallam, Arnold, Marryatt, Miss Mitford, Countess D'Arblay, Stewart, Lord Brougham, Dr. Chalmers, etc.

*Query.*—What are the principal works of Sir Walter Scott? Who wrote "Come, ye Disconsolate"? Who is the author of "From Greenland's Icy Mountains"? With whom did English prose begin? Ans. "Venerable Bede." Who was the father of English printing? Who created the historical novel? Ans. Sir Walter Scott. Who was the "Wizard of the North"? Why? How long was Gray writing his "Elegy"?

*NOTE.*—THE SORROWS OF GENIUS. Homer was a beggar; Plautus turned a mill; Terrus was a slave; Paul Borghese had fourteen trades, and yet starved with them all; Tasso was often distressed for five shillings; Bentivoglio was refused admittance into an hospital he had himself founded; Cervantes died of hunger; the celebrated writer of the "*Lusiad*" ended his days, it is said, in an almshouse; Vagelas left his body to the surgeons to pay his debts, as far as the money would go; Bacon lived a life of distress; Sir Walter Raleigh died on the scaffold; Milton sold his copyright of "*Paradise Lost*" for fifteen pounds at three payments, and finished his life in obscurity; Dryden lived in poverty and distress; Otway died in hunger and neglect; Lee died in the street; Steele lived all his days fighting the sheriff's officers; Goldsmith's "*Vicar of Wakefield*" was sold for a trifle to save him from the grip of the law; Fielding lies in the burying-ground of the English factory at Lisbon, without a stone to mark the spot; Savage died in prison at Bristol, where he was confined for the debt of eight pounds; Butler lived a life of great poverty, and died poor; Chatterton, the child of genius and misfortunes, destroyed himself.

## 39. Who wrote "William Tell"?

ANS.—James Sheridan Knowles (1784–1862) wrote the play of "*William Tell*" in English, and the greatest dramatic work of Schiller (1759–1805) was "*Wilhelm Tell*," of course in the German language. Knowles was an Irishman famous as an actor, elocutionist, and dramatic author of such plays as "*Virginius*" and "*William Tell*." He became a Baptist minister in his old age, wrote some controversial works, and died at Torquay. Schiller was, next to Goethe, the greatest German poet, and the author of "*Wallenstein*," the "*Robbers*," etc.

## 40. Who were the French authors of the eighteenth century?

ANS.—Montesquieu (1689–1755), "*Lettres Persannes*," "*Esprit des Lois*"; Voltaire (1694–1778), "*Henriade*," "*Age of Louis XIV.*," "*History of Charles XII.*"; Buffon (1707–1788), "*Histoire Naturelle*"; and Rousseau (1712–1778) who was obliged to leave France on the publication of his "*Contrat Social*."

Query.—Who were Mozart, Haydn, Canova, Jacquard, Lessing, Handel, Reynolds, West, and Gainsborough? Who was "*Kitt North*"?

## 41. Who are the poets of the Victorian Age?

ANS.—Alfred Tennyson, "*The Princess*," "*Locksley Hall*," "*The May Queen*," "*Maud*," "*Enoch Arden*," "*Idyls of the King*"; Robert Browning, "*My Lost Duchess*," "*How They Brought the Good News from Ghent to Aix*," "*A Blot on the Scutcheon*," "*The Ring and the Book*"; Elizabeth Barrett Browning, "*Aurora Leigh*," "*Casa Guidi Windows*," "*Lady Geraldine's Courtship*," "*He Giveth His*



*Beloved Sleep*"; Jean Ingelow, "*Songs*," "*High Tide on the Coast of Lincolnshire*," "*Off the Skelligs*"; Algernon Charles Swinburne, "*Laus Veneris*," "*Atalanta in Calydon*," "*Bothwell*"; Gerrald Massey, "*The Babe Christabel*," "*The Wee White Rose*"; Lord Lytton ("*Owen Meredith*"), "*Lucille*," "*Fables in Verse*"; and Coventry Patmore, Mrs. Norton, Mackay, etc.

Query.—Who is the "golden-tressed Adelaide"? Where is found

"'Tis better to have loved and lost  
Than never to have loved at all"?

Who is the author of "*Frankenstein*"? Who are the authors of "*Tommy's Dead*" and "*Legends of Inverburn*"? What are the five greatest epics known to the world? Ans. Homer's "*Iliad*," Virgil's "*Aeneid*," Dante's "*Divine Comedy*," Tasso's "*Jerusalem Delivered*," and Milton's "*Paradise Lost*." Is "*Pilgrim's Progress*" an epic, lyric, novel, or allegory?

NOTE.—This age, one of great productiveness in literature, is very prolific in prose writers. Among "the immortal names that were not born to die" are: Thomas Babington Macaulay, "*Lays of Ancient Rome*," "*Horatius at the Bridge*," "*History of England*"; Charles Dickens, "*Pickwick*," "*Martin Chuzzlewit*," "*Bleak House*," "*Our Mutual Friend*," "*David Copperfield*"; William Makepeace Thackeray, "*Vanity Fair*," "*The Virginians*," "*Pendennis*," "*The English Humorists*"; Sir Edward Bulwer-Lytton, "*Rienzi*," "*The Caxtons*," "*Pelham*," "*The Last Days of Pompeii*," "*Richelieu*," and "*Lady of Lyons*"; George Elliot (Mrs. Lewes), "*Romola*," "*The Mill on the Floss*," "*Adam Bede*," "*Middlemarch*"; Charles Darwin, "*The Origin of Species*," "*The Descent of Man*"; Thomas Carlyle, "*Sartor Resartus*," "*Hero Worship*," "*Life of Frederick the Great*"; John Ruskin, "*Modern Painters*," "*Seven Lamps*," "*Stones of Venice*"; Charles Reade, "*Peg Woffington*," "*Griffith Gaunt*," "*Never too Late to Mend*"; Canon Kingsley, "*Alton Locke*," "*Hypatia*"; Charles Lever, "*Charles O'Malley*," "*Harry Lorrequer*"; Samuel Lover, "*Rory O'More*," "*Molly Bawn*"; Samuel Warren, "*Ten Thousand a Year*"; Charlotte Bronte (Currer Bell), "*Jane Eyre*," "*Shirley*," "*Villette*"; Wilkie Collins, "*Armada*," "*The Moon-*

stone," "Woman in White" "No Name"; Dinah Muloch Craik, "John Halifax, Gentleman"; Thomas Hughes, "School Days at Rugby"; M. E. Braddon; Edmund Yates; B. L. Farjeon; Agnes Strickland; Benjamin D'Israeli, "Vivian Grey," "The Young Duke," "Lothair," "Endymion"; Froude, the historian; Anthony Trollope; Grote, author of "History of Greece"; Alison; George Macdonald; Mrs. Wood; John Stuart Mill; Hugh Miller; Dean (R. C.) Trench; Max Muller; and the scientists—Huxley, Tyndall, and Spencer, etc., etc.

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### Recreations.

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According to Bartlett's "Familiar Quotations," the authors most frequently quoted from are—the order indicating their popularity—Shakespeare, Milton, Pope, Byron, Wordsworth, Goldsmith, Gray, Tennyson, Moore, Scott, Dryden, and Butler's "*Hudibras*." Of course the Bible is by far the most popular source of quotations, and Shakespeare stands next. But the writer whose works are read the least of the names given above is Alexander Pope. Yet he is the author who furnishes next to Shakespeare and Milton the largest number of popular quotations. The following list will give some idea of his popularity:

*"Shoot folly as it flies,  
And catch the manners living as they rise."*

"Lo, the poor Indian." "All are but parts of one stupendous whole." "Whatever is, is right." "The proper study of mankind is man." "He can't be wrong whose life is in the right." "Order is Heaven's first law." "Pleas'd with a rattle, tickled with a straw." "Act well your part—there all the honor lies." "An honest man's the noblest work of God." "Look through nature up to nature's God." "From grave to gay, from lively to severe." "Guide, philosopher and friend." "Just as the twig is bent the tree's inclined." "Who shall decide when doctors disagree?" "Damn with faint

praise." "The feast of reason and the flow of soul."

"Do good by stealth, and blush to find it fame."

The so-called prophecy of *Mother Shipton* was as follows:

"Carriages without horses shall go,  
And accidents fill the world with woe.  
Around the world thoughts shall fly,  
In the twinkling of an eye.  
Water shall yet more wonders do,  
Very strange, yet shall be true.  
The world upside down shall be,  
And coin be found at roots of tree.  
Through hills men shall ride,  
And no horse or ass shall be at his side.  
Under water men shall walk,  
Shall ride, shall sleep, shall talk.  
In the air men shall be seen  
In white, in black, in green.  
Iron in the water shall float  
As easy as an wooden boat.  
Gold shall be found, and found  
In a land that's not now known.  
Fire and water shall wonders do,  
England at last shall admit a Jew.  
The world to an end shall come  
In eighteen hundred and eighty-one.

It is claimed that this was written and published first in 1488 and republished in 1641, and that it is the more wonderful as all the predictions, with the exception of the last, have been verified. Whether such a woman ever lived, is not known; but the prophecy is a clever hoax, and is the product of the brain of Charles Hindley, of Brighton, England, who about the year 1862 published what pretended to be a reissue of an old work containing, among other articles by "*Mother Shipton*," this wonderful document.

42. What are the three periods of American literature?

Ans.—I. The Colonial Age, 1640–1760; II. The Revolutionary Age, 1760–1830; III. The National Age, 1830–1882.

NOTE.—The writers of the Colonial Age were principally theologians. Its chief literary representatives are Cotton Mather—*"Magnalia Christi Americana"* and *"Memorable Providences Relating to Witchcraft"*—and Jonathan Edwards, whose great work was *"An Inquiry into the Freedom of the Will."*

43. Who are the poets of the Revolutionary Age?

James Rodman Drake, *"The American Flag"* and *"The Culprit Fay"*; Fitz-Greene Halleck, *"Marco Bozzaris"*; Francis Scott Key, *"Star Spangled Banner"*; Judge Joseph Hopkinson, *"Hail Columbia,"* and Judge Francis Hopkinson, his father, who wrote *"The Battle of the Kegs"*; Clement C. Moore, *"A Visit from St. Nicholas"* (*"'Twas the night before Christmas"*); Samuel Woodworth, *"The Old Oxen Bucket"*; and a few minor poets.

NOTE.—The prose writers of this age generally furnish us the "solid matter" to be found in the works of Hamilton, John Adams, Madison, Jefferson, Kent, Story, Wirt, Dwight, Audobon, Channing, Witherspoon, Wilson, and the *"Poor Richard's Maxims"* of Franklin.

44. Who represent the "Golden Age" of American literature?

Ans.—William Cullen Bryant, *"Thanatopsis,"* *"Song of the Stars"*; Henry Wadsworth Longfellow, *"Evangeline,"* *"The Bridge,"* *"Outre Mer,"* *"Kavanagh,"* *"Hyperion"*; John Greenleaf Whittier, *"Maud Muller,"* *"Snow-Bound,"* *"Barbara Frietchie,"* *"A Tent on the Beach"*; James Russell Lowell, *"The Biglow Papers,"* *"True Noble-*



ness," *"First Snowfall"*; Oliver Wendell Holmes, *"Autocrat of the Breakfast Table," "One Hoss Shay," "Old Ironsides"*; Edgar Allen Poe, *"The Raven," "The Bells"*; John Godfrey Saxe, *"Briefless Barrister," "Proud Miss MacBride"*; Thomas Buchanan Read, *"Sheridan's Ride," "Drifting"*; Bayard Taylor, *"Story of Kennett," "Masque of the Gods," "Song of the Camp"*; Alice and Phoebe Cary, *"Clovernoak," "Married, not Mated," "The Poet to the Painter"*; Thomas Bailey Aldrich, *"The Face Against the Pane," "Babie Bell"*; Edmund Clarence Stedman, *"John Brown of Ossawatimie"*; J. G. Holland, *"Bitter-Sweet," "Kathrina," "Timothy Titcomb's Letters," "Sevenoaks"*; Francis Bret Harte, *"Heathen Chinee," "A Newport Romance"*; Joaquin Miller, *"Songs of the Sierras," "Burns and Byron"*; John Howard Payne, *"Home Sweet Home"*; N. P. Willis, *"People I have Met"*; Nathaniel Hawthorne, *"Marble Faun," "Twice-Told Tales," "The Scarlet Letter"*; Harriet Beecher Stowe, *"Uncle Tom's Cabin"*; Edward Eggleston, *"Hoosier Schoolmaster"*; Samuel L. Clemens, *"Innocents Abroad," "Gilded Age"*; and Irving, Prescott, Bancroft, Sprague, Stoddard, Whitman, Pierpont, Dana, Percival, Boker, Morris, Cooper, Everett, Webster, Sumner, Agassiz, Emerson, White, Parker, Henry Ward Beecher, Parton, Lossing, Simms, Cooke, Arthur, Trowbridge, Mrs. Moulton, Miss Alcott, Mrs. Evans-Wilson, Hale, Mitchell, Mann, *"Fanny Fern,"* etc., etc.

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### Gems.

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"Reading maketh a full man, conference a ready man and writing an exact man."—BACON.

"He\* left a name at which the world grew pale,  
To point a moral or adorn a tale."—DR. JOHNSON.

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\*Referring to Charles XII, of Sweden.

"A handful of red sand, from the hot clime  
Of Arab deserts brought,  
Within this glass becomes the spy of time,  
The minister of thought."—LONGFELLOW.

"Next to the originator of a good sentence is the first  
quoter of it."—EMERSON.

"Tell me tales of thy first love—  
April hopes, the fools of chance—  
Till the graves begin to move,  
And the dead begin to dance."—TENNYSON.

"Here's a sigh to those that love me,  
And a smile to those that hate,  
And whatever sky's above me,  
Here's a heart for any fate."—BYRON.

"Drink to me only with thy eyes,  
And I will pledge with mine;  
Or leave but a kiss in the cup,  
And I'll not ask for wine."—BEN JONSON.

"Dream, dream, heart of my own love!  
Sweet is the wind from the odorous South—  
Sweet is the island we sail to alone, love—  
Sweet is a kiss from thy ruddy young mouth."  
—MORTIMER COLLINS.

From "*Lucille*":

"He who seeks one thing in life and but one,  
May hope to achieve it before life be done.  
But he who seeks all things wherever he goes,  
Only reaps from the hopes which around him he sows  
A harvest of barren regrets."—LORD LYTTON.

### Food for Thought.

Who was Hipparchus? What does the phrase "to pass the Rubicon" signify? Who is the most voluminous English poet? Who were the Poets Laureate? Who wrote Peter Bell? What was George Cruikshank? What English poet achieved distinction despite the loss of eye-

sight? Who is the author of the Theory of Evolution, epitomized in the familiar expression, "the survival of the fittest"? What were the works of Goethe, Béranger, Richter, Guizot, Hugo, Verne, Thiers, Pushkin, and Dumas? Have you read Burton's "*Anatomy of Melancholy*"? Who wrote "*The Arcadia*"? Who is the author of "*Mother Goose*"? What is Cæsar's "*De Bello Gallico*"? Who was G. P. R. James? What Pope published *Pagani*'s version of the Bible? Who was Confucius? What plays of Shakespeare are drawn from English history, and over what period do they extend? What do we mean by the classic productions of an age? Who are the leading characters in "*Romeo and Juliet*"? Who wrote "Phormio," "Pro Murena," "Lycidas," "Cato," "Much Ado About Nothing," "Village Blacksmith," "Vicar of Wakefield," "Toilers of the Sea," "Heathen Chinees," "Gulliver's Travels," "Marco Bozzaris," "Rasselas," "Hiawatha," "Fable of the Critics," "Excursion," "Jane Eyre," "Moonstone," "The Task," and "Faerie Queen"?







# GENERAL HISTORY.

THE END OF THE WORLD

# GENERAL HISTORY.

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## 1. What is History ?

Ans.—The word History is of Greek origin, signifying in that language a learning or knowing by inquiry, and in English a record of past events, or it may be defined in a general way as the record of the life of mankind. In a more special view, it is the narrative of the rise and progress of those famous peoples whose doings constitute the history of civilization.

Query.—What is Biography? What is Autobiography? What is political history? What is meant by the Philosophy of History?

NOTE.—The branches of study necessary to a proper understanding of this subject are Ethnology, Archæology, Philology, Geology and Physical Geography. These researches belong properly to Anthropology, which deals with man in natural history rather than to history proper.

## 2. What are the divisions of history?

Ans.—*Ancient*, extending from the earliest times to the fall of the Western Roman Empire, 476 A. D., and *modern*, beginning with the downfall of Rome, and extending to the present time.

NOTE.—Some historians make a triple division of Ancient, Mediæval and Modern, and the interval, from the fifth to the fifteenth century, is regarded as the period of Mediæval history, or the history of the Middle Ages. The subdivisions are: (1) the history of the group of ancient Oriental Nations, the Egyptians, the

Assyro-Babylonians, the Hebrews, the Phoenicians, the Hindoos and the Persians; (2) the history of Greece; (3) the history of Rome; (4) the history of the Middle Ages; (5) the history of the modern European states and nations, including that of the United States and America in general.

3. What country has the oldest authentic history?

Ans.—Egypt, “the Gift of the Nile,” beginning with the accession of Menes, placed by some scholars (as Bunsen) at 3906; others bring it down as late as 2700.

4. What are the three periods of Egyptian history?

Ans.—The First (or period of the old empire), from 2700 B. C., to 2080; the Second (or the era covered by the rule of the *Hyksos* or *Shepherd Kings*), from 2080 to 1527; the Third (or period of the new empire, down to the destruction of Egyptian independence by the Persians), from 1527 to 525.

NOTE.—According to Manetho, the native historian, twenty-six dynasties of kings ruled the country during these three periods. The Israelites were in Egypt during the reign of the *Hyksos*. It is known that Abraham visited Egypt in the 20th century B. C. Though there is a difference of opinion as to the time of the Exodus, it is believed to have taken place 1320 B. C., during the reign of Menetha, the fourth king of the nineteenth dynasty,—the Pharaoh whose “heart was hardened,” and who was drowned in the Red Sea.

Query.—Who is called the Father of History? What are hieroglyphics? Who was Suphis or Cheops? What are *annals*, *chronicles* and *memoirs*? What is the Sphinx? For what purpose were the Pyramids built? Who was Sesostris?

5. What were the Six Great Monarchies of



the Ancient World? Give a brief history of each.

ANS.—Babylonia, Assyria, Chaldea, Media, Persia, and Parthia. The first (called in the Bible the "Plains of Shinar") and its chief city were founded by Nimrod about 2247 B. D. A century later the city of Nineveh, the capital of Assyria, was founded by Ninus, who conquered the Babylonians. The history of this country is divided into two periods, and during the second was the splendid reign of Sennacherib (705-681), who made extensive conquests and was the builder of magnificent structures at Nineveh. The Assyrian empire ended with the fall of Sardanapalus, who was overcome by the Medes in 605 B. C. Chaldea was the name of the southwest portion of ancient Babylonia, bordering on Arabia. It was the ancestral home of the patriarch Abraham. When Alexander the Great took possession of Babylon, 331 B. C., he found a series of astronomical observations taken by the Chaldeans for an unbroken period of 1903 years. This people became masters of Babylon about 747 B. C. Their fall occurred when "the golden city" was destroyed by the Medes under Cyrus, 538 B. C. Media was a province of Assyria which revolted and became independent about 875 B. C. Its separate existence terminated when it was united to Persia by Cyrus. Persia, the "Elam" of the Bible, was subdued by the Assyrians in the ninth century before Christ. Cyrus became their ruler in 538 B. C., and Alexander the Great, after defeating the Persians in several battles, made it a Grecian monarchy 331 B. C. Parthia became subjected to the Persians. In the year 53 B. C., Orassus, at the head of a Roman army, invaded the country and was defeated. But as a warlike people the Parthians disappear from history A. D. 226.

*Query.*—Who were the builders of the Tower of Babel? What city was traversed diagonally by the Euphrates? What were the seven wonders of the world? What four cities were established by Nimrod? Give an account of the Assyrian Empire, and of the siege and capture of its chief city.

## 6. What is the history of the Hebrews?

*Ans.*—The most complete history of a people of the Semitic race is that of the Hebrews, contained in the Bible, generally called sacred history. Jewish national history begins with the Exodus, and, from that event to the absorption of Judea in the Roman empire, 63 B. C., it is divided into four periods. Their kingdom reached its zenith under Solomon, 1015–975 B. C. Under his successor, Rehoboam, ten of the twelve tribes revolted and formed the Kingdom of Israel, which was conquered by Assyria in 721 B. C. Jerusalem, the capital of the Kingdom of Judah (two tribes), was captured by Nebuchadnezzar, 586 B. C., and the people were carried into captivity to Babylon for 70 years. The siege and destruction of Jerusalem by Titus took place in the year 70 A. D.

*NOTE.*—The two great races that appeared on the vast tablelands of Asia at a remote period in the past, were the Aryan and Semitic. The Aryan race receives its name from a Sanskrit word meaning “noble,” and the Semitic is named for Shem, the son of Noah. These two great races have always been antagonistic to each other, and in the contests the Aryans have almost invariably triumphed.

## 7. Who were the Phœnicians?

*Ans.*—A Semitic race who were the earliest commercial and colonizing people on the shores of the Mediterranean. It is believed they were emigrants from Chaldea. They founded the colony of Carthage and, pushing their way beyond what the Greeks called the “Pillars of Hercules”

(Strait of Gibraltar), built the city of Gades (Cadiz), and visited the southern ports of the British Islands. Their chief cities were Tyre and Sidon. The former was captured 585 B. C., by Nebuchadnezzar, after a siege of 13 years, and again by Alexander the Great, 332 B. C., when 8,000 Tyrians were massacred, and 30,000 sold into slavery.

8. Give an account of the Persians and Hindoos.

Ans.—They are the two Asiatic representatives of the great Aryan race. The Persians, who were emigrants into Persia, were originally subject to the Medes. After Cyrus had thrown off the Median yoke, the two peoples became united, under the empire of the Medes and Persians. As before stated, Cyrus captured Babylon, and his son Cambyses, a cruel, bloodthirsty tyrant, conquered Egypt, 525 B. C. Darius I. was the greatest of the Persian monarchs. His son Xerxes, invading Greece, was ignominiously defeated. The empire was finally overthrown by Alexander the Great at the battle of *Arbela*, Oct. 1st, 431 B. C. The Hindos, leaving their native seat, first settled in the northwestern part of India about the year 3000 B. C. The first historical notice that we have of India in relation with Europe is by the invasion of Alexander the Great, 326 B. C. Its condition then corresponds almost exactly with what may be seen at the present day.

Query.—From what was the dye of the celebrated Tyrian purple made? What are the four *castes* of the Hindoos? What is the *Shah Nameh*? Who was Zoroaster? What was Magianism? What is Buddhism?

9. When was the beginning of Grecian history?

ANS.—Its earliest history is involved in mystery of which the myth-makers have taken the fullest advantage, giving the world a system of mythology that has always been a subject of study as well as a source whence the poets of subsequent ages have drawn many of their choicest embellishments; but its history proper begins with the first celebration of the Olympian games, 776 B. C.

NOTE.—The Heroic Age, so called from the exploits of heroes which are related in the myths, legends and poems of Homer, extended from the earliest times to about 1100 B. C. From the *Iliad* we derive our record of the Trojan War, which occurred 1184 B. C. Venus promised Paris, the son of Priam, king of Troy, and Hecuba, that he should have to wife the handsomest woman in the world, Helen, wife of Menelaus, king of Sparta. In the absence of her husband, Paris carried Helen to his home in Troy, and to obtain her, the princes of Greece, under command of Agamemnon, a brother of the injured husband, undertook an expedition that resulted in the restoration of Helen and the destruction of Troy after a siege of ten years.

10. What are the three periods of Grecian history?

ANS.—From the Dorian migration to the beginning of the Persian Wars (1100–500 B. C.) 2. From the beginning of the Persian Wars to the subjugation of Greece by Philip of Macedon (500–338 B. C.). 3. From the subjugation of Greece by Philip to the Roman conquest (338–146 B. C.).

NOTE.—The two leading races were the Ionians and the Dorians. The Greeks always called their country *Hellas* and themselves *Hellenes*. The four principal cities, Athens, Sparta, Corinth and Thebes, are said to have been founded about 1500 B. C.

11. Give an account of Sparta.

ANS.—She was the first to rise to prominence, and the ascendancy which she acquired over the other states of



the Peloponnesus was mainly owing to her peculiar institutions founded by *Lycurgus* about 850 B. C. His leading idea was the elevation of the state above the individual, and he divided the people into three classes, the *Spartans*, the *Laconians*, and the *Helots*, or *serfs*. After the laws of Lycurgus had been confirmed by the oracle at Delphi, he caused the Spartans to bind themselves by an oath never to change them until his return from a journey he proposed to make. Upon this he went away and was never again heard of.

12. What city was the great rival of Sparta?

ANS.—Athens. Until the death of Codrus, 1068 B. C., it was governed by kings; afterward by nine elected officers, who were called Archons. These, in conjunction with the nobles, constituted the supreme court of the Areopagus, established by Solon 594 B. C.

NOTE.—The wise laws of Solon aimed at the gradual erection of a democracy, and Athens was the first *real republic*, but they were frustrated for a time by the tyrant Pisistratus and his two sons, Hippias and Hipparchus. Hippias, usurping the government of Athens, B. C. 560, enjoyed a splendid reign of 33 years, after which Hipparchus was slain in a popular tumult, and his brother was expelled from Athens 510 B. C.

Query.—What is meant by Spartan bravery? What was the *Code of Draco*? Who were the "Seven Wise Men"? What is *ostracism*?

13. What were the Grecian wars?

ANS.—Sparta was engaged three times in war with her neighbors in Messenia, 743 to 723, 685 to 668, and 464 to 455, and the Persian War; which grew out of trouble between the Greek colonies on the Asiatic coast and Persia, commenced about 495 B. C. by the Ionian revolt. This

was easily crushed by Darius, and, the first expedition sent to conquer Greece, in 492 B. C., having proved abortive, he organized an extensive army and landed on the plains of Marathon in the year 490 B. C. The *one hundred thousand* invaders were met by an Athenian army of *ten thousand* men under command of ten generals, among whom were Miltiades, Themistocles and Aristides, and were totally defeated. Only 192 Greeks fell.

14. When was the second invasion ?

ANS.—In the year 485 B. C. A mighty host, variously estimated, (Herodotus says it consisted of 2,600,000 men), under Xerxes, met the Spartans and Athenians at the *Pass of Thermopylæ*. Leonidas with 300 Spartans and 700 Thespians, after a traitor had betrayed to the Persians a passage over the mountains, repulsed two chosen bodies of troops, but being attacked in front and rear they all perished, fighting desperately. The Spartans abandoned the Athenians and commenced fortifying the Isthmus of Corinth. Athens was burned by the Persians.

15. Give an account of the battle of Salamis.

ANS.—Themistocles, availing himself of the fleet that his foresight had provided, gained so complete a victory that Xerxes in despair commenced a hasty retreat, leaving, however, an army of 300,000 men, which attacked the people of Attica in the spring of 479 B. C. The Greeks rallied under Pausanias and Aristides, and defeated the enemy with tremendous slaughter at *Platæa*. On the same day, the Persian fleet was nearly wholly destroyed at *Mycale*. For the succeeding ten years there were conflicts between the Greeks and Persians, but in 469 B. C. a peace was concluded which ended the Persian rule.

**Query.**—What became of Themistocles, Miltiades and Pausanias? When was the "Golden Age of Pericles"? What is the Parthenon? Who were the writers of comedy and tragedy? By whom was oratory practised? Who was Pheidippides? **Ans.**—The Athenian runner boy who ran two days, two nights, "over the hills, under the dales, down pits and up peaks," from Athens to Sparta, to demand aid for his city against the Persian. As reward, on the Marathon day he was allowed to run again, with the tidings, "Rejoice, we conquer!" but the "joy in his blood bursting his heart, he died," his country freed.

## 16. When was the Peloponnesian War?

**Ans.** The prosperity of Athens caused jealousy on the part of the Spartans, and in 430 B. C. the Peloponnesian states formed an alliance to oppose the Athenians and their allies. The conflict was maintained with varying fortunes until 404 B. C., when the power of Athens had vanished, and it was placed under the government of the "Thirty Tyrants," illustrious, aristocratic Athenians, who were the allies of Sparta.

**NOTE.**—Xenophon's *Anabasis* gives an account of the retreat of the 10,000 Greeks (who went to assist the revolt of Cyrus, the younger son of Artaxerxes, king of Persia,) after the defeat of Cyrus at *Cunaxa*, and the killing of the Greek generals who had been invited to a council.

## 17. Who was Epaminondas?

**Ans.**—The general of Thebes who defeated the Spartans at *Leuctra* 371 B. C., by which Thebes became the leading state,

## 18. When was the Macedonian Conquest?

In the year 338 B. C., the Great Philip, king of Macedonia, in spite of the efforts of Demosthenes and the valor

of the Thebans, gained the battle of *Chæronea*, the Athenians and their allies were defeated, and Greece was never again free.

*Query.*—When was the Corinthian War? What was the "*Achæan League*"? Name the battles of Alexander the Great. Who were Archimedes and Hippocrates? What are *Philippics*?

### 19. Who was the "Mistress of the World"?

*Ans.*—Rome. Her history extends from the foundation of the city by Romulus, 753 B. C., to its destruction by the Vandals, A.D. 455. The three periods of her history are: 1, The mythical and traditional age of the *Kings*, 753–510 B. C.; 2, The heroic age of the *Republic*, 510–27 B. C; and, 3, The Golden Age of the *Emperors*, 27 B. C.—455 A. D. The Gauls sacked the city 389 B. C., destroying all the records, and the trustworthy history of Rome really begins no earlier than 281 B. C.

*NOTE.*—The legends of the age of seven kings tell us of the wonderful preservation of Romulus and Remus; the rape of the Sabine women; the wise reign of Numa Pompilius, and his conferences with the nymph Egeria; the wars of Tullus Hostilius and Ancus Martius; the combat between the Horatii and the Curatii; while the early traditions tell us how Tarquinius Priscus founded the Capitol, and recount the murder of Tarquin and his successor, Servius Tullius, and the final banishment of the last of the kings, Tarquinius Superbus. The people were at first divided into patricians and plebeians. After the expulsion of the Tarquins, the supreme authority was placed in the hands of two officers, called at first *prætors*, afterward *consuls*. The stern Lucius Junius Brutus and Tarquinius Collatinus were the first to hold this office.

*Query.*—Have you read Macaulay's "*Lays*"? Who was Cincinnatus? Who were the *decemviri*?

### 20. What is the date of the Punic Wars?

*Ans.*—After becoming mistress of all Italy, by contests



with the Samnites and other peoples, Rome began to extend her conquests outside of her dominions. The Romans and Carthaginians had become jealous of each other, and the pretext for a war was found when the inhabitants of Sicily invoked the help of Rome against Carthage. The first Punic war, beginning 265 B. C., in which the Roman General Regulus was defeated, made a prisoner, and it is said was put to death with horrible tortures, resulted in the confirmation of the claims of Rome upon Sicily 242 B. C., and in the payment of the expenses of the war by Carthage, amounting to \$2,500,000. Hannibal, the Carthaginian general, reopened hostilities by encamping in Italy in 218 B. C. Superseded by Paulus, the battle of *Cannae* was fought, in which 80 senators and 47,000 Roman citizens perished, but Scipio Africanus forced Hannibal to leave Italy for the protection of Carthage, and at the battle of *Zama*, 202 B. C., routed the Carthaginian army. In the third Punic war, 149-146 B. C., Carthage was utterly destroyed, and her territory became a Roman province.

NOTE.—Besides these wars, the Romans were involved in three with Macedonia. I. 214-205 B. C.; II. 200-197 B. C.; and III. 172-168 B. C., terminating by the battle of *Pydna*. The power of Rome was now supreme.

Query.—Who were the "*Gracchi*?" When was the Numidian War? Who were the *Cimbri* and *Teutones*? What was the Social War? Who was Spartacus? Who was Polybius?

## 21. What was the Triumvirate?

ANS.—The rule of three men, Pompey, Cæsar, and Crassus. Pompey had defeated Mithridates, king of Pontus, in three wars, and the Pontian kingdom was annexed to Rome. After the union of these men, Pompey remained in Rome, Crassus went to Syria where he was



killed, and Julius Cæsar reduced the Belgians, Gauls, and Helvetians, 51 B. C. The death of Crassus left the supreme power to be struggled for by his two associates. Cæsar crossed the Rubicon and marched on to Rome. Pompey fled, but collecting an army met Cæsar near Pharsalus in Thessaly and was defeated, August 9, B. C. 48. He escaped to Egypt where he was assassinated.

NOTE.—In the Roman calendar, the *ides* meant the *thirteenth* day of each month except in March, May, July, and October, in which months it was the *fifteenth* day. The *ides* of March was the day on which Cæsar was assassinated in the Senate house by Cassius, Brutus, and other conspirators, 44 B. C.

22. When was the Second Triumvirate formed?

ANS.—In the year 43 B. C., by Mark Antony, Octavius and Lepidus. As soon as possible, Lepidus was deprived of all power, while Octavius strengthened himself in Rome, and Antony lived in luxury with Cleopatra, queen of Egypt. The absolute government of the Roman world was decided at the battle of *Actium*, 31 B. C. Antony and Cleopatra fled, and both died by their own hands. Octavius, who was now supreme ruler, took the new title, Augustus. His reign is termed the Augustan, or Golden Age of literature.

23. What was the Prætorian Guard?

ANS.—The body-guard concentrated by Tiberius (A. D. 14–37), the stepson and successor of Augustus, near Rome under General Sejanus. They became the real sovereigns of the empire. Tiberius was succeeded by Caligula, one of the most bloodthirsty tyrants that ever lived, and, after him, Nero reigned from 54 to 68 A. D. He was followed

by Galba, Otho, and Vitellius, A. D. 68-70, and Vespasian A. D. 70-79.

NOTE.—Vespasian was succeeded by his son, Titus, the Roman general that destroyed Jerusalem in 70, and Titus by his brother, the tyrant Domitian, who was the last of the *Twelve Cæsars*. Numerous emperors ruled the empire down to the year 476; the mild Nerva: Trajan, the *best*; Hadrian, the patron of literature; Pius, the *loving*, etc.; but Rome was in a state of decline from the death of Marcus Aurelius, 180, until its division by the sons of Constantine the Great into the *Eastern* and *Western* Empire, 364, and its final destruction by the Vandals.

*Query*.—Who was Tacitus? When was the first eruption of Vesuvius? Who was Caracalla? By whom was Zenobia made a prisoner?

#### 24. Give an account of Constantine the Great.

ANS.—His reign (324-337) is remarkable for the establishment of Christianity as the religion of the Roman Empire. On his march home from Gaul, where he had been employed, he is said to have seen in the heavens a flaming cross inscribed in Greek words, “*In this emblem conquer*” (*In hoc signo vinces*), which led to his inscribing his banners and shields with the cross. In 325 he convened the celebrated *Council of Nice*, and declared Christianity to be the official religion. Byzantium, the capital, was called Constantinople in his honor. At the division of the empire by his two sons, Valens took the eastern half, with his capital at Constantinople, and Valentinian, the western, with the capital at Rome.

#### 25. Who were the Goths and Vandals?

ANS.—The influx of the ferocious Huns into Europe in 375, led to the downfall of the Western Empire. Alaric invaded Greece in 395, advanced toward the west in 402, and the next year frightened the Romans into a promise of

an annual tribute. In 409 and 410, he captured the city twice, and the second time pillaged and partly burned it. The last victory achieved in the name of Rome, was the defeat of Attila, "the Scourge of God," king of the Huns, at Chalons, in France, 451. A third tribe of barbarians, the Vandals, under command of Genseric, their ablest monarch, after surprising Carthage, entered Rome in June, 455. "For fourteen days the city was devoted to fire and pillage, and large collections of its valuables were carried away to Carthage." Romulus Augustus, the last of the emperors, a handsome, but feeble youth, was pensioned off in 476. Odoacer, a son of one of the ministers of Attila, became the Gothic *King of Italy*.

26. When was the last of the gladiators?

Ans.—In the year 404, Telemachus, an eastern monk, suddenly appeared in the Arena of the Colosseum at Rome between two gladiators, and, with prayer and gesture, bore his testimony against these unchristian games. The Prætor Alybius immediately ordered his slaughter. Struck with his grand heroism, the Emperor Honorius abolished the shows, and never after were they permitted. Telemachus was canonized, and is now in the Saint's Calendar.

27. Who were the Saracens?

Ans.—The term is applied to the Arabs and their descendants, who conquered a large part of Asia, Africa and Europe, early in the seventh century. They were Mohammedans, or believers in Mohammed (or Mahomet), who was a camel driver of Mecca. He preached a new religion, called *Islam*, "salvation." The written creed is the *Koran*. The inhabitants of Mecca, disgusted with the tenets of the new religion and the personal habits of Mohammed, drove him from the city in 622. This is the

Mohammedan era, and from the prophet's flight, the *Hegira*, time is reckoned among the Turks and Saracens.

*Query.*—What is the history of Italy down to the time of Charlemagne? What became of Odoacer? What is feudalism? When were the “Dark Ages”? Define chivalry.

## 28. Who was Peter the Hermit?

ANS.—Jerusalem was taken by the Turks in 1073, and the Christians were taxed, plundered, persecuted or slaughtered. Stories of these troubles were brought back by returning pilgrims, some of whom had been unable so much as to enter the city whose streets they so longed to tread, but no exaggerations were sufficient to deter the deluded people of Europe from continuing their pilgrimages. Among these “*palmers*” was Peter the Hermit (1050–1115), who, being encouraged by a vision he professed to have seen while in the Holy City, began, in 1094, to preach the deliverance of the Holy Land through all the countries of Europe.

NOTE.—The empress Helena, mother of Constantine the Great, (following the example of the faithful, who from the earliest Christian times had been in the habit of visiting different places made sacred by the life of our Savior) marked her pilgrimage by churches which she caused to be erected. Her son built a church over the supposed site of the Holy Sepulchre. Pilgrimages were encouraged by every possible means, and their neglect was at a later period regarded as impiety.

## 29. Give the history of the Crusades?

ANS.—Pope Urban, at the Council of Clermont in 1095, instigated his hearers to release that illustrious land (Palestine) from a race of heathen. The extension of the *Truce of God*, which was an effort on the part of the church to mitigate the evils arising from the private wars of feudal times, furthered the plan, and finally Peter's eloquence,



acting first upon the masses, then upon the higher nobility, moved the sovereigns to join in the Crusades. August 15, 1069, was the day fixed for the first great expedition, but early in the spring, the Hermit, impatient of delay, started with a great rabble under Walter the Penniless. These soon returned. Godfrey de Bouillon, Duke of Lorraine, started at the appointed time, conducting his great army to Constantinople, capturing the city of Nice in 1097, and arriving at Jerusalem in 1099. The attack was made on July 14th, and the next day they entered the city, massacring the Turks in great numbers. Bouillon was made king with the title of *Defender of the Holy Sepulchre*.

NOTE.—In all there were eight crusades. The third (1187) was the most important and interesting, from the great men prominent in it—*Saladin, Frederic Barbarossa, Philip II., Richard I., Cœur de Lion*. Following, the fourth was the strange crusade of the children in 1212. The four following, of minor interest and importance, occurred in the years 1217, 1228, 1248, and 1270.

### 30. When began the rise of Popery?

ANS.—The papacy first became a *temporal* power at the close of the eighth century. Pepin, of France, invaded Italy to rescue it from the Lombards, and gave Ravenna to the pope. During the next three centuries, the sovereigns were endeavoring to restrict the power of the ecclesiastics, and this antagonism culminated in the outbreak between Henry IV., Emperor of Germany, and Pope Gregory VII., better known by his surname, *Hildebrand*. There have been more than two hundred and fifty popes from the earliest date to the present time. Their history has complicated the events of every country in Europe. After the Reformation (1520), the influence of the Pope gradually declined. His *temporal* power ended in 1870, when Victor Emanuel, King of Italy, took possession of the "States of the Church."



**Query.**—What were the "*investitures*?" What absolution did Henry IV. undergo? Who were the Guelphs and Ghibellines? When did the popes reside at Avignon?

### 31. Give an account of Venice.

**Ans.**—Venice rose into distinction as a republic early in the fourteenth century, as Genoa was losing her political independence, though the Venetians boast immemorial freedom. The city was a commercial power before Genoa and Pisa had entered mercantile pursuits, and she was in a position to be enriched by the crusades.

**NOTE.**—From 1350 to 1500, there is no general history of Italy, for the cities were ruled by local families, and the period is marked by a succession of dissensions and civil wars.

### 32. Who was Beatrice Cenci?

**Ans.**—A remarkably beautiful girl who was born about 1583, and executed in September, 1599, when she was but sixteen years old. Her father, Francesco Cenci, subjected her and her step-mother to atrocious cruelties. Beatrice vainly appealed to Pope Clement VIII. for protection, and she and her step-mother determined to rid themselves of their unnatural persecutor. On September 9th, 1598, they drugged Francesco, and Beatrice introduced assassins into his room, where he was murdered while asleep. One of the murderers made a full confession of the homicide, implicating Beatrice, her step-mother, and two brothers as being parties to the crime. They were tried for murder, and all, save the younger brother, were found guilty, and subsequently executed. To the last moment, Beatrice displayed the most heroic courage, and her youth and beauty were so great that her execution caused a thrill of horror throughout Rome.

## "GUIDO'S MASTERPIECE."

There stands, on one of Rome's far famous hills,  
 The palace of the Barberini race:  
 Within, amidst the varied art which fills  
 The walls, there hangs the painting of a face.

33. What are the six dynasties of the German empire?

ANS.—The *Carlovingian*, (481-911); the *Saxon*, (919-1024); the *Franconian*, (1024-1125); the *Suabian*, or *Hohenstaufen*, (1138-1254); the house of *Hapsburg*, (1273-1438); and the house of *Austria*, (1438-1882).

NOTE.—From the "migration of nations" about 370, we can trace the origin of the Germans from the Franks and Burgundians of the Visi-Goths, or West Goths. Charlemagne (742-814) was a wonderful man, worthy to be, as he was, Charles the Great, and Charles the First, both of the French and German and Roman empires. He was crowned "Emperor of the West" by the Pope of Rome, Christmas day, 800, and after married Irene, Queen of Byzantium. This coronation revived, *in name*, the Roman Empire. But the new empire depended on him alone, as his death fully proved. In 722, he began a war for the extension of the Christian religion. He defeated the Lombards, subdued the Saxons, and was obliged to interfere between the Moors and Arabs in Spain.

34. What is said of his successors?

ANS.—They were men of inferior capacity. The first, *Louis le Débonnaire*, (778-840), in 807 divided his empire among his three sons. France, Italy and Germany thus became practically independent of one another. Louis II., 846-879, was succeeded by Charles III., 822-888, called the *Fat*, who, proving weak and imbecile, was deposed by the German princes, and his nephew Arnulf elected as his successor. The Carlovingian line ended in *his* son, Louis III.

## 35. Who were the rulers of the Saxon dynasty?

Ans.—Henry I., 876-936, who conquered the Slavonians and Hungarians at the battle of *Museburg*; Otho the Great, 912-973; Otho II., 955-983, called the *Red* from his complexion, and the *Bloody* from his cruelty; Otho III., 980-1002; and Henry II., 972-1024.

NOTE.—During the reign of Otho the Great lived the Bishop Hatto, whose name is associated with the legend of the "Mouse Tower" on the Rhine, upon which Southey has founded a ballad, though the story of his having been devoured by rats is thought to be of much later origin.

## 36. Who was Conrad the Suabian?

Ans.—The first ruler under the Franconian Dynasty, succeeded by his son, Henry III, 1017-1056, and followed by Henry IV.,—to whom reference has already been made—Henry V., and Lothaire.

## 37. What noted incident occurred in 1140?

Ans.—Conrad III., the first emperor under the Hohenstaufen Dynasty, in 1138 made war against Guélphus, Duke of Bavaria, and laid siege to the city of Weinsburg. The women, finding that the town could not possibly hold out long, petitioned the emperor that they might be allowed to depart out of it, carrying their "dearest jewels." Conrad, knowing that they could not convey away many of their effects, granted their petition, when, to his great surprise, the women came out of the place bearing their husbands on their backs. The emperor was so moved at the sight that he burst into tears, and after having extolled the women for their conjugal affection, gave the men to their wives, and received the duke into his favor.

## 38. Who was Frederic Barbarossa?

Ans.—The most powerful and brilliant emperor that Germany has ever had. He died in 1190, while on the third crusade, and was succeeded by his son, Henry VI, 1165-1197.

NOTE.—The reign of many of these emperors was signalized by the never-ending conflicts of the Guelphs and the Ghibellines, interrupted by the rule of Frederick II., from 1194 to 1250.

## ✓ 39. Who were the Rulers of the House of Hapsburg?

Ans.—Count Rudolph, 1218-1291. Adolphus of Nassau, who died in 1298, and was succeeded by the son of Rodolph, Albert I., a severe and despotic ruler, who was murdered in 1308. The Swiss Republic was founded this year, and its independence acknowledged in 1499. To this period belongs the legend of William and his shooting of Gessler. Henry VII. was elected emperor in 1308, and died in 1313. During the reign of Charles IV., Rienzi, 1313-1354, made an effort "to realize the bright dreams of Italian unity, which have fatally inspired so many patriots from Dante to Mazzani and Garibaldi." Wenceslaus, the son of Charles, was defeated at the battle of *Sempach*, 1386, by the Swiss, through the sacrifice of Arnold von Winkelried.

NOTE.—The mariner's compass, gunpowder and cannon came into use early in the 14th century. The invention of printing is claimed by the Germans and Dutch. Gutenberg, a German, printed a quarto Bible about 1450, a copy of which in excellent preservation was sold for \$8,000 at the Brinley book sale, Hartford, Conn., April 11th, 1831.

Query.—Who was John Huss? When were the Hussite Wars? Who were Jerome and John Zischka? What was the Hanseatic League? the Suabian League? Give the history of Maximilian I.

## 40. What was the Reformation?

Ans.—Tetzel, agent of Pope Leo X., had been sent to preach indulgence to those who gave money for the building of the church of St. Peter at Rome, and he did so in such extreme terms—absolving the holder of an “*indulgence*” not only from sins committed but even from sins that he *intended to commit*—that he aroused Martin Luther, 1483–1546, a theological lecturer at the University of Wittenberg, to publish, in 1517, a series of *ninety-five theses*, boldly opposing this traffic. Summoned before the Diet of Worms, Luther was ordered to retract, but boldly refused to do so. Burning a bull of the pope, in which his writings were denounced, in 1520, he was declared a heretic. The people, in pursuance of what they supposed to be his wishes, engaged in riotous proceedings, and this was followed by the *Peasants’ War* of 1525, causing the loss of 100,000 lives and the destruction of many monasteries and castles of the nobles. The “*Augsburg Confession*” was signed by seven princes and fifteen cities, who protested against the resolutions of the Diet of Spire in 1529. The treaty of Augsburg (1555) granted religious liberty to the Protestant states of Germany.

## 41. Who was Charles V.?

Ans.—Successor to Charles IV., of Germany, and usually called Charles I., of Spain. In 1524, he commenced war against Italy. The French, who held northern Italy, were driven out, and their king, Francis I., 1494–1547, was sent as prisoner to Madrid. The celebrated Chevalier Bayard was killed at the beginning of this war. In 1555, he abdicated his throne, giving the dominion of the Netherlands, Spain, Naples, and the New World to his son, Philip II. During his reign, 1540, arose the order of Jesuits, under their leader, Ignatius Loyola, 1491–1556.



## 42. When was the Thirty Years' War?

Ans.—Germany was the theatre of a succession of wars from 1618 to 1648. They arose from the differences of religious faith. The two noted men during this war were Gustavus Adolphus, King of Sweden, who was killed at the battle of *Lutzen*, November 6th, 1632; and Albert von Wallenstein, who led the imperial forces against Gustavus, and was assassinated in 1634.

NOTE.—After this war Germany never regained its former proud position, and the two kingdoms of Austria and Prussia rose into great importance. Leopold I., of Hungary, 1640-1705, held his country against violent attacks of the Turks, and was engaged in three wars with Louis XIV., of France. In the last was fought the celebrated battle of *Blenheim*, in 1704.

## 43. Who were the five great generals of modern times?

Ans.—Prince Eugene, who gained the battles of Peterwardein (1716) and Beldrade (1717), Wellington, Napoleon, Marlborough, and Frederic the Great.

## 44. When was the Seven Years' War?

Ans.—It was fought at the same time of our French and Indian war; *i. e.*, from 1756 to 1763. Maria Theresa, daughter of Charles VI., engaged in this war with Frederic the Great, which gained glory for Prussia, but was of no advantage to Austria.

## 45. What Austrian Monarch fought Napoleon?

Ans.—Francis I., in 1809, entered upon a very disastrous war, costing him a large portion of his territory, forcing him to enter into an alliance with the French em-

peror against Russia, and allowing Napoleon to marry his daughter, Maria Louisa. His successor, Ferdinand I., was engaged in the conflict with Louis Kossuth in 1848.

NOTE.—Frederic the Great, of Prussia, was succeeded by Frederic William II., 1744-1797; Frederic William III., 1770-1840; Frederic William IV., 1795-1861; and William I., 1797—.

Query.—What was the Schleswig-Holstein difficulty? When was the battle of *Sadowa* fought? Who is Prince von Bismark-Schcenhausen?

#### 46. What is the history of France?

ANS.—The first king of France was Eudes, or Hugh, crowned in 888. He was succeeded by Charles III., who was so intimidated by the northman, Chief Rollo, that in 912 he gave to him the hand of his daughter, with the present territory of Normandy as dowry. Rollo became the first duke of Normandy, and the ancestor of William the Conqueror.

NOTE.—The history of France, under the Carlovingian dynasty and the House of Capet, is intimately associated with that of Germany. A succession of petty wars and the participation of its monarchs in the crusades are the only matters of interest up to the founding of the House of Valois in 1328.

#### 47. What was the Hundred Years' War?

ANS.—A struggle on the part of England for the crown of France. By the battle of *Agincourt*, October 15, 1415, most of the French territory was given up to the English, but, in 1429, Jeanne D'Arc, the "*Maid of Orleans*," a young peasant girl twenty years of age, at the head of the French army, animated by enthusiasm, gained some minor victories. Subsequently she was taken by the English, and burned alive in the market place at Rouen. Charles VII., though treating this tragedy with indifference, entered upon the war with so much vigor that by

1453 the whole of France, excepting Calais, was restored. His successors were Louis XI., Charles VIII., Louis XII., and Francis I., whose reign is remarkable for the persecutions of the Protestants.

48. When was the massacre of St. Bartholomew?

ANS.—It occurred on St. Bartholomew's Eve, August 24, 1572. The dreadful work began upon the ringing of the bell of the church of St. Germain l'Anxerroy opposite the palace. The victims in the city were estimated as high as 10,000. By royal order of Charles IX., the massacre was extended to the provinces, where 30,000 more were slain.

49. What was the Edict of Nantes?

ANS.—An Edict by Henry IV. (Navarre) in which he granted religious toleration to the Protestants. It was passed April 13, 1598, and revoked by Louis XIV., October 22, 1685. The *revocation* caused the emigration of 50,000 Protestant families, some of whom settled in Charleston, S. C.

50. How was the House of Bourbon established?

ANS.—By a severe contest, in which Henry VI. defeated Mayenne, general of the "League," at the battle of *Iry*, in 1590. The Bourbons ruled from 1589 to 1792. Louis XVI. was guillotined on the 21st of January "amid the wild shouts of the people," and in less than a month after the Queen Marie Antoinette was beheaded. These were the days of the Revolution, in which the National Assem-

bly ruled France; the Bastile was stormed; the streets were drenched with human blood; and the names of the crafty Talleyrand, the good Lafayette, and the notorious Danton, Marat, and Robespierre, are written on her history.

### 51. Who was known as "Le Petit Corporal"?

Ans.—This was a term of endearment applied to Napoleon Bonaparte, 1769–1821, by the French army. From the time of his dispersion of the National Guard, October 4, 1796, to his final defeat at Waterloo, June 18, 1815, he was successively engaged in establishing himself as Emperor of the French; crowning his brothers Joseph, King of Naples, and Louis, King of Holland; subduing Italy; humbling Austria; conquering Spain; and defeating the allied armies of Russia, Prussia, and England.

NOTE.—The house of Orleans, established in 1830, was ended by the revolution of 1848. From the latter date to 1852, a republic existed under the presidency of Louis Napoleon, who, by his coup d'etat of December 2, managed to have himself proclaimed emperor, as Napoleon III. Uniting his forces with those of Victor Emanuel, the two emperors gained the battles of *Magenta* and *Solfertino* over the Austrians, in June, 1859.

Query.—When was the Franco-Prussian War? What was the result of the battle of *Sedan*? Who was first president of the new French republic? Who is the present incumbent?

### 52. Give the history of Spain.

Ans.—In 711, the Moors, Arabs, or Saracens as they are also called, came from Africa and conquered nearly the whole of Spain, establishing their capital at Cordova. Their supremacy was gradually reduced, and, in 1492, all Moors and Jews were banished from the country by Ferdinand and Isabella. Ferdinand was succeeded by Charles I.

also emperor of Germany, who abdicated in favor of his son, Philip II. The principal aim of Philip's life was the extension of the Romish Church. He was engaged in conflicts with the Pope, the Sultan, and Henry II. of France. Upon his return, he attended an *auto-de fé*, act of faith, at which fourteen Protestants, condemned by the Inquisition, were burned at the stake. His "War with the Netherlands," and the "Invincible Armada" sent against England were both unsuccessful.

NOTE.—The independence of the United States of Holland was formally acknowledged in 1648. The southern provinces called Belgium, after varying fortunes declared themselves independent in 1830, placing Leopold I. on the throne. Her independence was acknowledged by Holland in 1833.

53. When was the naval power of Spain destroyed?

Ans.—In 1805, at the battle of Trafalgar, when Lord Nelson, at the cost of his own life, gained a decisive victory over the allied fleets of Spain and France under the command of Count Villeneuve.

NOTE.—The remainder of Spanish history is principally that of a series of internal dissensions and revolutions, the partisan warfare carried on by Don Carlos within the past few years being a sample of the afflictions of Spain.

54. Who were the Angles?

Ans.—Savage tribes dwelling in the lowlands of North Germany, who, with the Jutes and Saxons, invaded Briton about 450 and waged war on both Romans and Britons. The country became known as Angleland from the Angles, and this name finally became the modern name England. The German invaders and the native Britons never coalesced. The latter were gradually exterminated and driven into Wales and Scotland.



## 55. Who were the conquerors of England?

Ans.—The Danes. After many invasions of the days of Egbert, who became king of England in 827, they conquered the country and ruled it from 1013 to 1041. Again, after having lived on the coasts of France, the same people, as Normans, under William the Conqueror overcame the English under King Harold at the battle of Hastings in 1066.

## 56. How long did the Plantagenets rule?

Ans.—From 1154 to 1485. Henry II., the first of this line of kings, is the one “who held the stirrup for Pope Alexander to mount his horse.” His reign is tarnished by the murder of Thomas à Becket in 1170. Henry was succeeded by Richard I., who started for the Holy Land soon after his coronation, leaving his brother John to rule England. The gentle outlaw of the Sherwood forest, Robin Hood, lived at this time. From John the nobles forced the signature of the *Magna Charta*, on the meadow of Runnymede, near Windsor, June 15, 1215.

NOTE.—John was followed by six kings, the last of whom, Richard II., 1366-1400, was only 11 years old at the time of his accession, the affairs of the kingdom being managed by his uncles, the dukes of Lancaster, York and Gloucester, whose family quarrels led to the *Wars of the Roses* in 1455-1485.

Query.—Who were the three kings of the House of Lancaster? When was Jack Cade's Rebellion? Who was the “*King-maker*”? What three kings had a white rose for a badge? What happened at Bosworth?

## 47. Who were the Tudors?

Ans.—The reigning family of Great Britain from 1485 to 1603. The first monarch, Henry VII., married Elizabeth, sister of the princes who were supposed to have been mur-

dered by Richard III., thus uniting the houses of Lancaster and York. He was succeeded by Henry VIII. with his six wives, Edward VI., Mary, and Queen Elizabeth. The latter was a patroness of literature, and her reign was a golden one. She gave aid to the Huguenots, took up the cause of the people of the Netherlands, and totally destroyed the *Spanish Armada* sent against England by Philip II., her former suitor. She was succeeded by James I., the beginning of the Stuart line. His son, Charles I., was beheaded on January 30, 1649.

### 58. When was the rule of the Commonwealth?

ANS.—Under Cromwell's Protectorate, from 1649 to 1660, when the Stuart line was restored in the person of Charles II. His reign was troubled with the insurrection of the *Fifth Monarchy Men*, the *Great Plague*, the *Great Fire*, the *Rye House Plot*, etc.

NOTE.—The house of Stuart and Nassau succeeded the revolution of 1688 and consequent flight of James II. to France, by the succession of William and Mary. Queen Anne reigned from 1702 to 1714. Then the House of Brunswick which still rules the destinies of Great Britain. The present sovereign, Queen Victoria, completed her sixty-third year on May 24th, 1832, an age which has only been exceeded by eleven of her predecessors, dating from the Norman conquest, viz : Henry I., Henry III., Edward I., Edward III., Queen Elizabeth, James II., George I., George II., George III., George IV., and William IV. To-day (June 20th) she has reigned for forty-five years, a reign which has been exceeded in length by only the three kings, Henry III., Edward III., and George III.

Query.—Who was Guy Fawkes? When was the battle of *Naseby* fought? Who tortured the Covenanters? Who was judge of the "*Bloody assize*" in 1685. When was the battle of *Culloden* fought? Who was king of England during the Revolutionary War? Give the history of Horatio Nelson. Who was called the *First Gentleman in Europe*? What victory was won by Sir John Moore?

## 59. What was the rise of the Dutch Republic?

Ans.—The Netherlands belonged to Spain at the time of the Reformation, but revolted in 1567 on the introduction of the *Inquisition*. Against Philip II., they made a determined resistance, led by "William the Silent," of Nassau, Prince of Orange. The war ended in 1609.

## 60. What is the history of China and Japan?

Ans.—But little was known, accurately, of these countries until the present century. China has a very ancient civilization, dating back to at least 2,000 B. C. The religion of the country is *Confucianism*, from Confucius, its founder. The Chinese are said to have invented the mariner's compass and gunpowder.

## 61. Who was King John Sobieski?

The ruler of Poland when she became one of the great powers in Europe. He compelled the Turks to raise the siege of Vienna in 1683. After this Poland rapidly declined, becoming a prey to internal dissensions and the rapacity of her neighbors. By the infamous agreement entered into between Austria, Prussia, and Russia, she was "partitioned" among these powers in 1772. A second and a third partition, in 1792 and 1795, wiped her from the list of nations. The unfortunate Poles made a gallant defence of their liberties, but in vain.

## 62. What country belongs to the Slavonian race?

Ans.—Russia. The early history of this country is unimportant. It was overrun by the Tartars in the 13th century. The invaders held the country for a long time,

and the Russian Dukes were considered vassals of the Tartar Khans. Ivan III., who became czar about the time that Elizabeth ascended the throne of England, delivered Russia from Tartar supremacy.

NOTE.—Peter the Great, who lives in the memory of Russians as the "Father of his Country," the head of the present royal family, was born in 1672, and was crowned when only ten years old. The familiar story of his working as a common ship-carpenter in Holland is too well known for recital. The war with Sweden was the great event of his reign. He died in 1725.

### 63. Who was Catherine the Great?

ANS.—Next to Peter the Great, the ablest and most successful of the Russian autocrats. During her reign of thirty-four years (1762–1796), she achieved the conquest of the Crimea, and won still more by her share in the "Partition of Poland." Suwarrow was her great general. She was succeeded by her son Paul, an eccentric, half-crazy creature, who was murdered in 1801. His son, Alexander I., came to the throne, and he was great-grandfather of the present Alexander III., who lives in mortal dread of the Nihilists.

Query.—What was the result of the Crimean War? When was the charge of the Six Hundred? How was Alexander II. assassinated? When was the battle of Warsaw? Who was Kosciusko?

### 65. Who were the rulers of Sweden?

ANS.—Sweden, belonging originally to Denmark, had revolted toward the end of the 15th century. Gustavus Vasa, leading the Swedes to victory, was crowned king in 1527. The next sovereigns were Queen Christiana, Charles X., Charles XI. and Charles XII., the "*Madman of the North*." The latter, after defeating the Poles and Danes, attacked a force of Russians ten times his own army, at

Narva, and totally defeated them. Laying siege to *Pultowa*, his army was destroyed, and he was obliged to flee to Turkey with 300 followers. He was finally killed by a cannon ball while besieging the castle of Fredericshall, in Norway, 1718. The head of the present family was Bernadotte, 1765-1844, a French officer, who took the title Charles XIV. He owed his elevation to his military reputation, and to the suffrages of the *Diet*.

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### Mnemonics.

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- 1750-63 { Seven Years' War in Europe,  
French and Indian War.
- { 1513-31 { Transposition. Balboa and Pizarro.  
1613-31 { Pocahontas's Marriage and Captain John  
Smith's death.
- { 1524-  
1531- } Voyages of Verrazani and Cartier.  
1534- } Conquest of Peru and DeSoto's death.  
1541- }
- June 28th { 1776—Sullivan's Island,  
1778—Battle of Monmouth.
- Aug. 16th { 1777—Battle of Bennington.  
1780—Battle of Camden.  
1812—Hull's Surrender at Detroit.
- Sept. 11th { 1813—Perry's Victory on Lake Erie.  
1814—McDonough's Victory, L. Champlain.
- { 1791  
1792- } Admission of States.  
1796 }  
1802+03  
1812- }
- April 19th { 1775 } First blood shed.  
1861 }
- { 1755-63  
1775-83
- { 1501  
1601  
1701  
1801



{	1816	Six States admitted.
	1817	
	1818	
	1819	
	1820	
	1821	

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### Query Box.

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When was the battle of Philippi fought? What was the temple of Janus? What questions were settled at the council of Nice? Who was the "*Old Man of the Mountains?*" What was the "heroic" event? Who was Genghis Khan? Where did the Franks settle? When did Lorenzo de' Medici live? Who were the "*Jacquerie?*" By whom was "*Ein feste burg ist unser Gott?*" composed? Describe the first crusade, giving its causes and its results. What comparison is there between the destruction of Jezebel, and the precipitation of traitors from the Tarpeian Rock at Rome? When were the Silesian Wars? Who assassinated Henry IV., of France? When did the Cardinal de Richelieu live? What king had the motto "*Ich dien?*" (I serve)? What three emperors commanded at Austerlitz? Whose fate was made the subject of a tragedy by Goethe? What was the *Inquisition?* When was the Conquest of Ireland? What is the oldest city in the world? Ans., Damascus. When was the Barons' War? Who was Wat Tyler? When and how was *Magna Charta* obtained? Who were Abelard and Heloisé? When was the "*Sepoy Rebellion?*" Who were the imposters of the reign of Henry VII.? What was the "*Reign of Terror?*" Who were the Jacobins? Name some of the great statesmen of Europe at the present time, giving the position which each occupies. When was the Unification of Italy? Who lived in a tub? How often did the Olympiads recur?

When and under what circumstances did Greece become a Roman province? Who added to each vote the expression, "*Delenda est Carthago?*" What is the only example of Semitic literature? What is the oldest literary monument of the Iranic race? Who were Æneas, Achilles, and Hector? Who was the "Old Man Eloquent?" What general was called "Old Hickory?" Who said "*Après moi le déluge?*" What were the Marian persecutions? When was "Black Friday?" When were the Articles of Confederation adopted? What three Congresses have we had? Who was the first proposer of secession in the U. S. Congress? Where are the Heights of Abraham? How did Maryland derive its name? Who was Molly Clark? What was *Le Bon Homme Richard*? Give an account of the guerillas, Mosby, Morgan and Quantrell. What is meant by the "salary grab?" What were the Alien and Sedition Laws? When was Iowa admitted? Who was the 14th president? Who was the rider of the Black Horse, at Saratoga? How many signers to the Declaration of Independence?





# ASTRONOMY.





# ASTRONOMY.

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1. What is Astronomy? ( $\alpha\sigma\tau\rho\omicron\nu$ , "star,"  $\nu\omicron\mu\acute{o}\varsigma$ , "law.")

ANS.—The most ancient of all sciences.

2. Define it.

ANS.—It is that science which teaches the knowledge of the celestial bodies, their magnitude, motions, distances, periods of revolution, eclipses, order, and of the causes of their various phenomena. This science depends on observations made chiefly with instruments, and upon mathematical observations.

NOTE.—The Chinese, who boast much of their astronomical discoveries, possess an account of a conjunction of four planets and the moon which must have occurred a century before the Flood. They have also the first record of an eclipse of the sun, which took place October 13th, 2187 B. C.—about 220 years after the Deluge. It is said that 2000 years before Christ one of their kings put to death the principal officers of state because they failed to calculate an approaching eclipse.

3. What are the celestial bodies?

ANS.—The sun and stars, moon and planets, comets and *nebulae*.

4. Define them.

ANS. The sun and stars are globes of the fiercest fire,

compared to which a mass of white hot iron is as cold as ice. They shine, or give out light, because they are *white-hot*. At their surfaces, masses of metals and other substances are mingling together with a heat more fierce than anything we can imagine. The planets are comparatively small bodies travelling around the sun at various distances from him. Our earth is one of them. They are all dark bodies—*obscure*, or *non-self-luminous*—and obtain their light and heat from the sun. The moon is a planet of the earth; it is to the earth what the earth is to the sun. In the moon we have a specimen of a third order of bodies, called *satellites*, or companions. The comets and nebulae are quite distinct from stars and planets, for they are in part masses of gas.

NOTE.—The nebulae lie far away from us, some of them perhaps out of our universe altogether: the comets rush for the most part from distant regions to our sun, and, having gone round him, they go back again, and we see them for a small part of their journey only. Nebulae and comets, like the stars, shine because they are white-hot; but in the case of stars we are dealing with incandescent, solid, liquid or densely gaseous matter, while in the case of the nebulae and comets, we are dealing with gas in a very rarefied state, and probably also at a lower temperature.

5. What is the difference in the appearance of a fixed star and of a planet?

ANS.—Those stars which shine with a clear, distinct light, and change their position with respect to the others, are called planets. Those which remain immovable, and shine with a shifting, twinkling light, are termed fixed stars, although it is now known that they also are in motion.

6. What are the two branches of Astronomy?

Ans.—1. Physical Astronomy, which deals with the laws of motion and the structure of the heavenly bodies; and, 2, Practical Astronomy, which teaches us how their movements may be made to help mankind.

Query.—From what two Greek words is the name Astronomy derived? What was the "Saros" or "Chaldean Period"? Eudoxus, who lived in the fourth century B.C., invented the theory of the *Crystalline Spheres*. What was it?

## 7. Who was Thales?

Ans.—One of the Seven Wise Men in the seventh century B. C., who established the first school of Astronomy in Greece. He taught that the earth is round, and that the moon receives her light from the sun. He introduced the division of the earth's surface into zones, and the theory of the obliquity of the ecliptic. He also predicted an eclipse of the sun, which is memorable in ancient history as having terminated a war between the Medes and Lydians. These nations were engaged in a fierce battle, but the awe produced by the darkening of the sun was so great that both sides threw down their arms and made peace. One of his pupils, Anaximander, erected the first sun-dial at Sparta.

## 8. What is the Ecliptic?

Ans.—The great circle of the heavens, along which the sun performs his annual path, so-called because when either sun or moon is eclipsed it is in this circle. Or the plane of the sun's apparent, and the earth's real motion.

NOTE.—From the remotest antiquity, the stars have been classified into groups called *constellations*, each constellation being fancifully named after some object which the arrangement of the stars composing it was thought to suggest.

## 9. When was the first classification of stars?

Ans.—About the year 150 A. D., made by Ptolemy, of Alexandria, who arranged the 1022 stars observed at Rhodes by Hipparchus, the Bithynian astronomer, of the second century B. C. His catalogue contains 48 constellations; two were added by Tycho Brahe, the celebrated Danish astronomer, and to these fifty (called the *ancient*) constellations, have been added in more modern times 59, carrying the number up to 109.

### 10. What is meant by “*magnitudes*?”

Ans.—All of the stars visible to the naked eye are divided into six classes of brightness, called magnitudes, so that we speak of a very brilliant one as “a star of the first magnitude”; of the feeblest visible, as a star of the sixth magnitude, and so on.

### 11. What are telescopic stars?

Ans.—The number of stars of all magnitudes visible to the naked eye is about 6,000; so that the greatest number visible at any one time—as we can see only one-half of the sky at once—is 3,000. If we employ a small telescope, this number is largely increased, as that instrument enables us to see stars too feeble to be perceived by the eye alone. Such stars are called “*telescopic stars*.”

NOTE.—The *zodiacal constellations* are to be distinguished from the signs of the zodiac bearing the same name. In English and in rhyme these are under:

“The Ram, the Bull, the Heavenly Twins,  
And next the Crab, the Lion shines,  
The Virgin and the Scales,  
The Scorpion, Archer, and He-goat,  
The man that bears the Watering-pot,  
And Fish with glittering tails.”

### 12. Who was Pythagoras?

Ans.—The founder of the second celebrated astronomi-

cal school, at Crotona, at which were educated hundreds of enthusiastic pupils. He knew the causes of eclipses, and calculated them by means of the Saros. He was most emphatically a dreamer. He conceived a system of the universe in many respects correct; yet he advanced no proof, and made few converts to his views, which were soon well-nigh forgotten.

### 13. What was the Copernican system?

ANS.—A revival of the theory of Pythagoras by Copernicus, the Prussian philosopher, about the middle of the 16th century. He was followed by Tycho Brahe, who propounded a modification of this system. Rejecting the ideas of cycles and epicycles, he was influenced by certain passages of Scripture to maintain with Ptolemy that the earth is the centre, and that all the heavenly bodies revolve about it daily in circular orbit.

NOTE.—Kepler, a pupil of Tycho, adopted the Copernican theory. His three laws were: 1. Planets revolve in ellipses, with the sun at one focus. 2. A line connecting the centre of the earth with the centre of the sun passes over equal spaces in equal times. 3. The squares of the times of revolution of the planets about the sun are proportional to the cubes of their mean distances from the sun.

Query.—What discoveries did Galileo make? What *recantation* was he obliged to make? Name some of the *northern constellations*—the *southern* ones.

### 14. Name the first magnitude stars.

ANS.—The twenty brightest stars in the heavens are as follows:

Sirius,	in the constellation Canis Major.		
Canopus,	"	"	Argo.
Alpha,	"	"	Centaur.
Arcturus,	"	"	Boötes.



Rigel,	in the constellation Orion.		
Capella,	"	"	Auriga.
Vega,	"	"	Lyra.
Procyon,	"	"	Canis Minor.
Betelgeuse,	"	"	Orion.
Achernar,	"	"	Eridanus.
Aldebaran,	"	"	Taurus.
Beta Centauri,	"	"	Centaur.
Alpha Crucis,	"	"	Crux.
Antares,	"	"	Scorpion.
Altair,	"	"	Aquila.
Spica,	"	"	Virgo.
Fomalhaut,	"	"	Piscis Australis.
Beta Crucis,	"	"	Crux.
Pollux,	"	"	Gemini.
Regulus,	"	"	Leo.

NOTE.—Although the stars, and the various constellations, retain the same relative positions that they did in ancient times, they are, nevertheless, in motion; and in some of them nearest to us this motion, called *proper motion*, is very apparent, and it has been measured. Thus Arcturus is travelling at the rate of *at least* 54 miles a second, or three times faster than our earth travels around the sun. Our Sun is approaching the constellation Hercules at the rate of 4 miles a second, carrying its system of planets, including our Earth, with it.

15. How many motions has the earth? Give velocity of each.

ANS.—The earth has two motions—the motion of the earth in space about the sun at the rate of about 1,000 miles per minute; and the diurnal revolutions of the earth on its own axis. Different points upon the earth's surface revolve with different velocities. At the poles the speed is nothing, while at the equator it is over 1,000 miles per hour. At Quito, the rate is about 1,038 miles per hour, at the

mouth of the St. Lawrence about 450 miles. In latitude  $40^{\circ}$  and  $41^{\circ}$ , the speed is respectively 795 and 780 miles per hour.

*Query.*—Why do we not perceive this wonderful velocity? What would be the result of a sudden cessation of the earth's rotation? If the rate of rotation were to increase? What are apparent motions? How caused?

### 16. What is the *Milky Way*?

Ans.—Winding among the stars is a beautiful belt of pale light spanning the sky, and frequently so situated as to divide the heavens into two nearly equal portions. It is composed of stars so faint, and apparently so near together, that the eye can only perceive a dim, continuous glitter. Of the 20,000,000 stars visible in powerful telescopes, at least 18,000,000 lie in and near the milky way.

### 17. What are the classes of stars?

Ans.—Double, Multiple, and Variable. Stars which appear single to the naked eye, appear double, triple, and quadruple, and, in some instances, the number of stars revolving round a common centre is even greater when viewed through a telescope. A beautiful star in the constellation of the Lyra appears as a faint single star. An opera-glass suffices to show it double, and a powerful instrument reveals the fact that each star composing this double is itself double; hence it is known as "the Double-double."

NOTE.—More than 6,000 double stars are now known, and of these motion has already been detected in nearly 700, the motion in some cases being very rapid. The brilliancy in the component stars varies so that a star of the first magnitude may have a companion of the tenth, twelfth or fourteenth magnitude. Sirius has, at least, one such companion. Stars in which the variation in the

light is, as it is generally, slow, regular, and within certain limits. are called *variables*.

*Query.*—What are *physical couples*? *optical couples*? What are *new stars*, *lost stars*, and *temporary stars*? Name some of the red, blue, green, yellow, and white stars. Do the colors of the stars change? What are *occults*? What are star-clusters? What is the *Pleiades*?

### 18. What are the classes of *nebulae*?

*Ans.*—1. Irregular nebulae. 2. Ring nebulae and elliptical nebulae. 3. Spiral, or whirlpool nebulae. 4. Planetary nebulae. 5. Nebulae surrounding stars. Some of the irregular nebulae—those in the constellations Orion and Andromeda, for example,—are visible to the naked eye on a dark night.

*NOTE.*—The nebulae vary slightly in color from a greenish white tinge to a planetary and bluish light. An idea of the extreme faintness of the more distant nebulae may be gathered from the fact that the light of a single sperm candle viewed at the distance of a quarter of a mile is 20,000 times more brilliant than the nebula. *A true nebula is a mass of glowing or incandescent gas.*

### 19. What is the “*nebular hypothesis*”?

*Ans.*—It supposes that all the matter which makes up the sun and the bodies revolving around it was at one time in a gaseous state, and whirling around a centre. By its centrifugal force, rings of matter were thrown off from the outside, which, obeying the law of attraction, formed into globes. These globes became the planets, the earth among the number.

### 20. Of what is the “*solar system*” composed?

*Ans.*—It consists of: 1. The sun—the centre; 2, the major planets—Vulcan (undetermined), Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune; 3, the

minor planets, at present 140 in number; 4, the satellites or moons, 20 in number, which revolve around the different planets; 5, meteors and shooting stars; 6, nine comets whose orbits have been computed, and over 1,200 of which but little is known; 7, the zodiacal light.

## 21. Describe the Sun.

ANS.—The centre of the universe, whose beam comes to us as simply motion of ether-waves, yet it is the grand source of beauty and power. Its heat, light and chemical force work everywhere the miracles of life and motion. The light of the sun is equal to 5,563 wax candles held at the distance of one foot from the eye. Its diameter is 853,380 miles. More than 1,200,000 Earths would be required to make one Sun. Astronomers express this by saying that the *volume* of the sun is 1,200,000 times greater than that of the earth, but as the matter of which the sun is composed weighs only one quarter as much, bulk for bulk, as do the materials of which the earth is made up, taken together, 300,000 Earths only would be required in one scale of a balance to weigh down the sun in the other. That is, the *mass*, or weight of the sun, is 300,000 times greater than that of our earth.

NOTE.—The average distance of the sun from the earth is about 91,500,000 miles. It seems a little larger to us in winter than in summer, as we are 3,000 miles nearer to it. The rotation of the sun on its axis was discovered by observing the spots on its surface.

## 22. What is meant by the *plane of the Ecliptic*?

ANS.—Imagine the earth floating around the sun on a boundless ocean, both sun and earth being half immersed

in it. This level, called the plane of the Ecliptic, is used by astronomers in precisely the same way as we commonly use the sea level. A mountain is so high above the level of the sea. Astronomers say that such a star is so high above the plane of the ecliptic.

*Query.*—How many motions has the sun? What are sun spots? How many motions have they? What is the meaning of *umbra* and *penumbra*? What is the *protosphere*? *nucleus*?

*NOTE.*—The spots on the sun appear to have been noticed as early as 807 A. D., although the telescope was not invented until 1610, and Galileo discovered the solar spots in the following year.

### 23. What are the Equinoxes?

*Ans.*—The points of intersection of the ecliptic and equator. When the sun occupies these positions in spring and autumn of the northern hemisphere, there is equal day and night all over the world, a small circle near each pole excepted. The *poles of the ecliptic* are the points where the axis of the earth's orbit meets the celestial sphere.

### 24. What is the celestial sphere?

*Ans.*—It is the blue arch of the sky, as it appears to be spread above us. The sun appears to be about half a degree in diameter, so that 360 disks like the sun, laid side by side, would make a half circle of the celestial sphere.

*NOTE.*—The apparent yearly motion of the sun is so important that astronomers map out the celestial sphere by a second method, in order to indicate his motion more easily: for as the plane of the celestial equator, like the plane of the terrestrial equator, does not coincide with the plane of the ecliptic, the sun's distance from the celestial equator varies every minute. To get over this difficulty, they make of the plane of the ecliptic a sort of second celestial equator. They apply the term *celestial latitude* to angular distances from it to the *poles of the heavens*, which are 90 degrees from it north and south. They apply the term *celestial longitude*



to the angular distance—reckoned on the plane of the ecliptic—from the position occupied by the sun at the vernal equinox, reckoning from left to right up to 360 degrees. This latitude and longitude may be either *heliocentric* or *geocentric*: that is, reckoned from the *centre*, either of the *sun* or of the *earth*, respectively.

## 25. What is the Zodiac?

ANS.—It is a belt of the celestial sphere, 8° on each side of the ecliptic, divided into twelve equal parts of 30° each. It is of very high antiquity, having been in use among the ancient Hindoos and Egyptians.

NOTE.—These signs, with their symbols, are as follows:

Spring Signs.	Summer Signs.	Autumn Signs.	Winter Signs.
♈ Aries.	♋ Cancer.	♎ Libra	♏ Capricornus.
♉ Taurus.	♌ Leo.	♏ Scorpio.	♐ Aquarius.
♊ Gemini.	♍ Virgo.	♐ Sagittarius.	♑ Pisces.

At the time these signs were adopted, the sun entered the constellation Aries at the vernal equinox, and occupied, in succession, the constellations bearing the same names; but at present, owing to the *precession* of the equinoxes, the signs no longer correspond with the constellations, which must not therefore be confounded with them.

## 26. What is the Zodiacal Light?

ANS.—A faint light, shaped like a sugar-loaf, is sometimes seen stretching obliquely upward in the heavens, from 70 to 100 degrees, from that part of the horizon where the sun is about rising or had just set. This phenomenon is known as the "*zodiacal light*." It is brightest and most distinctly defined in tropical regions, where it is visible most of the time. In high latitudes, it is seldom clearly seen, except during March and April just after sunset, and in September and October immediately before dawn. There are various theories as to its origin, but the *cause* of the zodiacal light is unknown.

## 27. What are the classes of planets?

ANS.—Inferior and Superior. The first, or those which travel around the sun within the earth's orbit, are Mercury and Venus. And the latter, outside of the earth's orbit, are Mars, Jupiter, Saturn, Uranus, and Neptune.

NOTE.—Mercury, Venus, Mars, Jupiter, and Saturn, being visible to the naked eye, were known to the ancients. Uranus was discovered in 1781 by Sir William Herschel, from whom it was first commonly called Herschel. Its discoverer gave it the name of *Georgium Sidus*, in honor of King George III. Both these names were discarded for the mythological one by which it is at present known. The first of the asteroids, Ceres, was discovered in 1801 by the Sicilian astronomer, Piazzi. Pallas was added to the list in 1801, Juno in 1804, Vesta in 1807, and the remainder since 1844. Neptune was discovered in 1846, by Dr. Galle, of Berlin. It was first called *Le Verrier*, in honor of an eminent French astronomer, who, by a series of calculations, established the fact that there was a more distant planet than Uranus, and instructed Dr. Galle in what part of the heavens to look for it.

### 28. What are the “*conjunctions*?”

ANS.—When an *inferior planet* is in a line *between the earth and sun*, it is said to be in INFERIOR CONJUNCTION with the sun: when it is in the same line, but *beyond the sun*, it is said to be in SUPERIOR CONJUNCTION. When a superior planet is on the opposite side of the sun,—that is, when the sun is between us and it,—we say it is in CONJUNCTION.

### 29. What is “*opposition*?”

ANS.—When a superior planet is in the same straight line, but with the earth in the middle, we say it is in OPPOSITION, because it is then in the part of the heavens opposite to the sun.

### 30. What is a “*transit*?”

Ans.—The passage of an inferior planet across the sun's disk.

31. What is "*occultation*?"

Ans.—When a planet or star is hid from the view of an observer on the earth, by the interposition of some other heavenly body, it is said to *suffer occultation*, or to be *eclipsed*.

*Query*.—What is the meaning of *horizon*, *zenith*, and *nadir*? What is the *sensible horizon*? Define the *rational horizon*.

32. Describe the Moon.

Ans.—The earth is attended by one satellite, called the Moon,—a beautiful orb which "rules the night" with its gentle brilliancy, produces in part the tides, and sensibly affects the earth's motions by its attraction. Its diameter is 2,165 miles, but its apparent size is almost equal to the sun's in consequence of its nearness to our planet. Its density is not much more than one half that of the earth, and it contains about one-eightieth as much matter.

33. What are its motions?

Ans.—It is about 240,000 miles from the earth, and revolves about the latter so as to reach the same point relatively to the fixed stars in 27 days, 8 hours. To reach the same point relative to the sun requires 29 days, 13 hours, since the earth has itself meanwhile advanced in its orbit.

34. What is the meaning of *Perigee* and *Apogee*?

Ans.—When nearest the earth, the moon is said to be

in her *perigee*, and when farthest from it, in her *apogee*. The terms *perigee* and *apogee* (which mean *near the earth* and *away from the earth*) are also applied to the apparent position of the sun. When the earth is at its *perihelion*, the sun is said to be in *perigee*; and when the earth is at its *aphelion*, the sun is in *apogee*.

NOTE.—The tides are caused by a great wave, which, raised by the moon's attraction, follows her in her course around the earth. The sun, also, aids somewhat in producing this effect; but as the moon is 400 times nearer the earth her influence is far greater.

35. What is meant by the phases of the moon?

ANS.—The moon revolves around the earth from west to east in about  $29\frac{1}{2}$  days, and the changes of her illuminated surface from a thin crescent to a circle, and *vice versa*, are called its phases. These changes depend upon the position of the moon relative to the earth and sun, for it is only the half of the moon facing the sun that is illuminated, and the whole of this portion can be seen from the earth only when the sun, earth and moon are in a straight line. The plane of her orbit does not coincide with the ecliptic, but is inclined to it at an angle of  $5^{\circ} 8' 47.9''$ , and intersects it in two opposite points called *nodes*. The "ascending node" is the point at which the moon penetrates the plane of the earth's orbit in passing from south to north. The "descending node" is crossed by the moon in returning south. If the moon happens to be *new* or *full* at either of these points, in one case we shall have an eclipse of the sun, and in the other an eclipse of the moon. If the moon's motion were performed in the plane of the ecliptic, we should have a solar eclipse at every new moon, and a lunar eclipse at every full moon. When the moon is not quite at a *node* at the time it is new or full, it is only partially eclipsed.

36. What is *quadrature*?

Ans.—It is the position of one heavenly body in respect to another when distant from it  $90^\circ$ . The moon is in her quadrature when at an equal distance from the points of “conjunction” and “opposition.”

### 37. Has the moon an atmosphere?

Ans.—Two reasons have been given why the moon has no atmosphere: 1, Because we never see any clouds there, and, 2, because when the moon's motion causes it to travel over a star, or to occult it, as it is called, the star disappears at once, and does not seem to linger on the edge, as it would do if there were an atmosphere; but during the recent total eclipse of the sun (May 17th, 1881,) the *savants* of the French expedition claim to have discovered a lunar atmosphere.

### 38. Is the moon inhabited?

Ans.—This question is often asked in reference to all of the heavenly bodies, but no evidences of inhabitants have ever been discovered, even in the moon, which is the nearest to us. Nothing, however, seems to be created without an object, and if the planets are inhabited, it must be by creatures constituted very differently from the human race. Surrounded by entirely different circumstances as regards temperature, gravity, atmosphere, etc., the inhabitants of the different planets must be races distinct from each other.

### 39. What is an eclipse of the sun or moon?

Ans.—An eclipse of the sun is caused by the moon passing between it and the earth, and intercepting its rays. When the moon intervenes between the sun and the earth at such a distance from the latter as to make her apparent



diameter less than the sun's, a singular phenomenon is exhibited. The whole disk of the sun is obscured, except a narrow ring around the outside encircling the darkened centre. This is called an Annular Eclipse, from the Latin *annulus*, a ring. An eclipse of the moon is caused by the earth getting between it and the sun.

NOTE.—The moon also turns on its axis in exactly the same time that it takes to revolve around the earth, and in the same direction. The consequence is that she always presents the same side to the earth. Nearly one-half of our fair attendant we never see, and to the inhabitants of half her surface, if she has any, we are invisible.

40. Describe the appearance of Mercury, and where seen.

ANS.—Mercury is nearest to the sun of any of the definitely known planets. Under favorable circumstances, it may be seen, at certain times of the year, for a few minutes after sunset or before sunrise, twinkling with a pale, rosy light. As the evening star, its elevation increases daily, but never exceeds  $30^{\circ}$ . Its mean distance from the sun is 35,000,000 miles. Its diameter is about 3,000 miles, and it revolves about the sun at the rate of 30 miles per second, completing the revolution in 88 days. Its volume is about one-twentieth that of the earth.

41. What is Venus?

ANS.—The most brilliant of all the planets. So bright is Venus that it is sometimes visible at mid-day to the naked eye, and in the absence of the moon casts a perceptible shadow. When visible before sunrise, it was called by the ancients Phosphorus, Lucifer, or the morning star, and when it shone in the evening after sunset, Hesperus, Vesper, or the evening star. It presents the same appear

ance as Mercury. Its diameter is 7,500 miles, and its mean distance from the sun is about 66,000,000. The volume of this planet is about four-fifths that of the earth, while the density is about the same. It completes its revolution around the sun in 225 days, at the mean rate of 22 miles a second.

NOTE.—The orbit of Mercury is the most eccentric of any of the eight principal planets, so that although when in perihelion it approaches to within 28,000,000 miles, in aphelion it speeds away 15,000,000 miles farther, or to the distance of 43,000,000 miles. The distance of Venus only varies at aphelion and perihelion within the limits of half a million miles.

#### 42. What is the meaning of eccentricity?

ANS.—The eccentricity of an orbit is the distance of either focus from the centre of the orbit. Greek, (*ἐκ*) *from*, and (*κέντρον*) the *centre*. The eccentricity of the earth's orbit is about  $1\frac{1}{2}$  millions of miles.

NOTE.—As the axis of Venus is very much inclined from a perpendicular, its seasons are similar to those of Mercury. The temperate and torrid zones overlap each other, the polar regions having alternately at one solstice a torrid temperature, and at the other a prolonged arctic cold. The inequality of the nights is very marked. The heat and light are double those of the earth, while the circular form of its orbit gives nearly an equal length to its four seasons.

#### 43. What would be the result if the axis of the earth were perpendicular to the ecliptic?

ANS.—The sun would always appear to move through the equinoctial: that is, those parts of the earth which lie under the equator would be constantly opposite to the sun; and as, in that case, the sun would at all times of the year be vertical to those places equally distant from both

poles, so the light and heat of the sun would be dispersed with perfect uniformity toward each pole; we should have no variety of seasons; day and night would be of the same length, and the heat of the sun would be of the same intensity throughout the year. There would be near the equator a fierce torrid heat, while north and south the climate would melt away into temperate spring, and, lastly, into the rigors of a perpetual winter.

#### 44. Give a description of Mars.

Ans.—It is the first of the superior planets, and the one most like the earth. It appears to the naked eye as a bright red star, rarely scintillating, and shining with a steady light, which distinguishes it from the fixed stars. Its ruddy appearance has led to its being celebrated among all nations. The Jews gave it the appellation of "blazing," and it bore in other languages a similar name. At conjunction, its apparent diameter is only about 4"; but once in two years it comes into opposition with the sun, when its diameter increases to 30". Mars not only has land and water and snow like us, but it has clouds and mists, and these have been watched at different times. The land is generally reddish when the planet's atmosphere is clear; this is due to the absorption of the atmosphere, as is the color of the setting sun with us. The water appears of a greenish tinge.

NOTE.—Mars revolves about the sun at a mean distance of about 140,000,000 miles, completing the revolution in 686 days, with an average velocity of 15 miles per second. Its diameter is a little less than 5,000 miles, while its volume is about one-fourth that of the earth.

#### 45. What is the largest planet?

Ans.—Jupiter. It is bright enough at times, in spite of its great distance, to cast a shadow like Venus, and is

surrounded by an atmosphere so densely laden with clouds that of the actual planet itself we know nothing. What are generally known as the *belts* of Jupiter are dusky streaks which cross a brighter background in directions generally parallel to the planet's equator. Its mean distance from the sun is 475,000,000 miles, and its velocity is about 500 miles per minute. The year at Jupiter contains 4,332 days. Its diameter is about 88,000 miles, and its volume is 1,400 times that of the earth.

46. When, by whom, and by what process, was the velocity of light ascertained?

ANS.—It was first found in 1676 by the Danish astronomer Roemer, by observations of the eclipses of Jupiter's moons. When the earth was nearest to Jupiter, the eclipses appeared about  $8\frac{1}{2}$  minutes too soon for the calculations, and when the earth was most remote from Jupiter, they were about  $8\frac{1}{2}$  minutes too late. Roemer concluded the reason to be that it required about 17 minutes for light from the planet to traverse the diameter of the earth's orbit, which measured the difference of the distances of the earth from Jupiter. If the diameter of the earth's orbit is 185,000,000 miles, that divided by  $17 \times 60 = 181,372$  miles a second. Bradley and others have verified the results, though some astronomers place the orbit at 182,000,000 miles, and deduce by a rule of three problem that light travels about 186,000 miles a second.

NOTE.—As the axis of Jupiter is but slightly inclined from a perpendicular to the plane of its orbit, there is but little difference in the length of its days and nights, which are each of about five hours' duration. At the poles, the sun is visible for nearly six years, and then remains set for the same length of time. The seasons vary but slightly. Summer reigns near the equator, while the temperate regions enjoy perpetual spring.

47. What is the planet next in size to Jupiter?

ANS.—Saturn, which is not only belted like Jupiter, but is surrounded by a series of rings, one of which, the inner one, is transparent. It is to the *rings* that most of the interest of this planet attaches. We may well imagine how sorely puzzled the earlier observers, with their very imperfect telescopes were by these strange appendages. The planet at first was supposed to resemble a vase, hence the name *Ansæ*, or handles, given to the rings in certain positions of the planet. It was next supposed to consist of three bodies, the largest one in the middle. The true nature of the rings was discovered by Huyghens in 1655.

NOTE.—This planet revolves about the sun at a mean distance of 872,000,000 miles, completing the revolution in 10,759 days. Its diameter is about 72,000 miles, and its volume nearly 750 times that of the earth. The light and heat of the sun at Saturn are only one one-hundredth that which we receive. The axis of Saturn is inclined from a perpendicular to the plane of its orbit about  $31^{\circ}$ . The seasons, therefore, are similar to those on the earth, but on a larger scale, each of them lasting more than seven of our years.

48. What is said of Uranus?

ANS.—It may be seen by a person of strong eyesight in a perfectly dark sky, if he previously knows its exact position among the stars. It is very faint, and this is due to its great distance from the earth. Were it as near the sun, it would appear twice as large as Jupiter. It revolves about the sun in 84 of our years, or 31,000 days. There being no spots on the surface, we are unable to fix the period of its revolution on its axis. Its distance from the sun is 1,754,000,000 miles, while its diameter is about 33,000 miles.



NOTE.—We know but little of the seasons of Uranus. Since its axis lies in the plane of its orbit, the sun winds in a spiral form around the whole planet. The light and heat are only three-thousandths of that which we receive; the light is about the quantity which would be afforded by 300 full moons. The inhabitants of Uranus can see Saturn, and perhaps Jupiter, but none of the planets within the orbit of the latter.

#### 49. Describe Neptune.

ANS.—It is the far-off sentinel at the very out-posts of the solar system, being the most distant planet of which we have any knowledge. It is invisible to the naked eye, and appears in the telescope as a star of the eighth magnitude. Its discovery is one of the greatest triumphs of which science can boast. Owing to its great distance from the sun, nothing is known of its physical peculiarities. It revolves about the sun at a mean distance of 2,750,000,000 miles, though its motion in its orbit is the slowest of any of the planets, being only 12,000 miles per hour.

NOTE.—Its annual revolution is completed in 165 terrestrial years, or 60,000 days. Its diameter is about 37,000 miles, while its volume is nearly 100 times that of the earth. As the inclination of its axis is unknown, nothing can be ascertained concerning its seasons. Its density is a little less than that of water, or about the same as that of Uranus.

#### 50. How many moons have the planets?

ANS.—The earth has *one*. Jupiter has *four*, and all but one of these satellites exceed our earth in size. The largest would sometimes be visible to the naked eye as a very faint star, were it not lost in the superior brightness of its planet. It has been inferred from the fact that their light varies, and that they are always brightest and duller in the same positions with regard to Jupiter and the sun, that

they rotate on their axes in the same time as they revolve around Jupiter. Three of them are totally eclipsed during every revolution by the long shadow which the planet casts, and the fourth is very often eclipsed. Saturn is surrounded by *eight* moons, seven of which were known for 60 years before the eighth was discovered. The largest of them has a diameter about half as large again as our moon. Mars has *two* moons. Uranus is attended by *four* moons, of which little is known, except the curious fact that their orbits are nearly perpendicular to the plane of the earth's orbit, and that they move from east to west, unlike the satellites of the other planets. Neptune has at least *one* moon, distant from it about as far as ours from us. The revolution of this about the planet, which is accomplished in six days, has furnished materials for calculating the mass of Neptune.

*Query.*—When cannot Jupiter be seen? How are Saturn's rings prevented from falling in upon the planet? How can Jupiter be eclipsed? Which one of the planets shines with a "steady, pale, yellow light"?

51. What is the *comparative size* of the planets?

*Ans.*—For illustration, taking a globe some two feet in diameter to represent the Sun, Mercury would now be proportionately represented by a grain of mustard seed, revolving in a circle 164 feet in diameter; Venus, a pea, in a circle of 284 feet in diameter; the Earth also a pea, at a distance of 215 feet; Mars, a rather large pin's head, in a circle of 654 feet; the smaller planets by grains of sand, in orbits of from 1,000 to 1,200 feet; Jupiter, a moderate sized orange, in a circle nearly half a mile across; Saturn, a small orange, in a circle of four-fifths of a mile; Uranus, a full-sized cherry, or small plum, upon the circumference

of a circle more than a mile and a half; and Neptune, a good-sized plum, in a circle of about two miles and a half in diameter.

NOTE.—As some difference exists in the statements of various authorities regarding the time of revolution, distances, etc., two leading tables are presented.

From Herschel's "Outlines of Astronomy" (1858):

Name.	Distance from Sun in miles.	Yr. expressed in Earth's d'ys.	Diameter in miles.
Mercury.....	36,890,000	88	3,183
Venus.....	68,770,000	225	8,108
Earth.....	95,298,000	365 $\frac{1}{4}$	7,926
Mars.....	145,205,000	687	4,546
Asteroids.....	{ from 210 to 391 millions.	from 1,191 to 2,051	estimated at from 100 to 1,000.
Jupiter.....	495,815,500	4,333	90,734
Saturn.....	909,029,700	10,759	76,791
Uranus.....	1,828,048,000	30,697	85,307
Neptune.....	2,862,404,000	60,128	89,793

From Lockyer's "Elementary Lessons in Astronomy" (1876):

	Distance in miles.	Period of revolution around the sun.			Diameter in miles.
		D.	H.	M.	
Mercury.....	35,392,000	87	23	15	2,962.
Venus.....	66,130,000	224	16	48	7,510.
Earth.....	91,430,000	365	6	9	7,901.
Mars.....	139,312,000	686	23	31	4,000.
Jupiter.....	475,693,000	4,333	14	2	85,390.
Saturn.....	872,135,000	10,759	5	16	71,904.
Uranus.....	1,752,851,000	30,686	17	21	33,024.
Neptune.....	2,746,271,000	60,118	0	0	36,620.

It is to be remembered that as the orbits are elliptical, the planets are sometimes nearer to the sun than at other times.

## 52. What is Bode's law?

Ans.—If we write down

0      3      6      12      24      48      96

and add 4 to each, we get

4      7      10      16      28      52      100

and this series of numbers represents very nearly the distances of the ancient planets from the sun, as follows:—

Mercury, Venus, Earth, Mars, ———, Jupiter, Saturn. This singular connection was discovered by Titius, and is known by the name of *Bode's Law*. The fifth term has apparently no representative among the planets. This fact acted so strongly on the imagination of Kepler that he boldly placed an undiscovered one in the gap. Up to the time of the discovery of Uranus, the undiscovered planet did not reveal itself.

NOTE.—When it was found, however, that the actual position of Uranus was very well represented by the next term of the series, 196, it was determined to make an organized search for it, and for this purpose a society of astronomers was formed, the zodiac was divided into 24 zones, each zone being confided to a member of the society. On the first day of the present century, a planet was discovered and named Ceres, which, curiously enough, filled up the gap,

53. Which of the asteroids can we see?

ANS.—None of these planets, except occasionally Ceres and Vesta, can be seen by the naked eye. Their chief characteristic is, that the largest minor planet is but 228 miles in diameter, and many of the smaller ones are less than 50.

NOTE.—The planet nearest the sun is (8) Flora, whose journey around the sun is performed in  $3\frac{1}{4}$  years, at a mean distance of 201,000,000 miles; the most distant one is (65) Maximiliana, whose year is as long as  $6\frac{1}{2}$  of ours, and whose mean distance is 813,000,000 miles.

54. What is the supposed origin of the asteroids?

ANS.—It has been suggested that they may be the fragments of a larger planet, which some believe to have originally revolved between Mars and Jupiter, and by

some tremendous catastrophe to have burst into fragments.

NOTE.—The asteroids are comparatively so diminutive that the force of gravity on their surfaces must be very small. A man placed on one of them would spring with ease sixty feet high, and sustain no greater shock in his descent than he does on the earth from leaping a yard. On such planets giants may exist; and those enormous animals which here require the buoyant power of water to counteract their weight, may there inhabit the land.

55. Which one has a hazy appearance?

ANS.—(2) Pallas; and it is supposed from this, that the planet is surrounded by a dense atmosphere. This may also be the case with the others, as their colors are not the same. There are also evidences that some among them rotate on their axes like the larger planets.

56. What are Comets?

ANS. Bodies, probably white-hot, shining by their own light, which perform their journeys around the sun in every plane, in orbits which are either ellipses, parabolas, or hyperbolas. They differ very much in appearance; but, for the most part, they consist of a *nucleus*, which is a very bright spot, apparently denser than the other portions; an *envelope*, or *coma* (hair), which is a luminous fog-like cover surrounding the nucleus; and a *tail*, which appears to be an expansion of the envelope produced by solar heat.

NOTE.—The tails of different comets differ greatly in shape and extent. In some, this appendage is entirely wanting; in others, it has been found to extend 112,000,000 miles. Several tails have been exhibited at the same time: the comet of 1744 threw out no less than six—like an enormous fan, over the heavens. Even in the same comet the tail keeps changing, being largest when near the sun, and diminishing as it recedes from that body. In 1853, the bright star Arcturus was seen through the tail of



Donati's comet, at a place where the tail was 90,000 miles in diameter. It is worthy of remark that in the year of the Norman invasion, 1066, a fine comet with three tails appeared, which in the Norman chronicle is given as evidence of William's divine right to invade England.

*Query.*—When is the next return of Halley's comet? How many tails had the comet of 1823? What are *short-period* and *long-period* comets? Which comet divided itself into two portions? When was DeVico's comet last observed? How near did the comet of 1680 approach the sun?

### 57. What are Meteors?

*Ans.*—Bodies which are called, according to their brilliancy, *meteors*, *bolides*, or *falling* or *shooting stars*, traversing the heavens in elliptic orbits around the sun. They are not scattered uniformly in the space comprised by the Solar System, but are collected into groups, and what we term a shower of meteors is due to the earth breaking through one of these groups. It has been calculated that the average number of meteors which traverse the atmosphere daily, and which are large enough to be visible to the naked eye on a dark, clear night, is no less than 7,500,000; and if we include meteors which would be visible in a telescope, this number will have to be increased to 400,000,000. *Aerolites* are those stony masses which fall to the earth.

**HISTORICAL NOTE.**—On April 26, 1803, a brilliant *fire-ball* (meteor) was seen traversing Normandy with great velocity, and some moments after, frightful explosions, like the noise of cannon or roll of musketry, were heard coming from a single black cloud hanging in a clear sky; they were prolonged for five or six minutes. These discharges were followed by a great shower of stones, some weighing over 24 pounds. One of the *earliest accounts* of star-showers is that which relates how, in 472, the sky at Constantinople appeared to be alive with flying stars and meteors. In some Eastern annals we are told that in October, 1202, "the

stars appeared like waves upon the sky. They flew about like grasshoppers, and were dispersed from left to right."

58. What is a sidereal day?

Ans.—*Star time*, or it is the exact interval of time in which the earth revolves on its axis. It is found by marking two successive passages of a star across the meridian of any place. This is so absolutely uniform that the length of the sidereal day has not varied one-hundredth of a second in 2,000 years.

59. What is a solar day?

Ans.—*Sun-time*, or the interval between two successive passages of the sun across the meridian of any place.

60. What causes the difference between a sidereal and a solar year?

Ans.—If the earth were stationary in its orbit, the solar day would be of the same length as the sidereal; but while the earth is turning around on its axis, it is going forward at the rate of  $360^\circ$  in a year, or about  $1^\circ$  per day. Therefore, when the earth has made a complete revolution, it must perform a part of another revolution through this additional degree, in order to bring the same meridian vertically under the sun. One degree of diurnal revolution is about equal to four minutes of time; hence the solar day is about four minutes longer than the sidereal day.

61. What is the distance of the fixed stars?

Ans.—The distance of the fixed stars is absolutely inconceivable. None of them can be less than 19,200,000,000,000 miles from the earth, while the greater part are far more remote. Their diameters are found to be enormous,

in one case not less than 200,000,000 miles. Sirius, if set in the place of our sun, would look 125 times as large as he, and give us 125 times as much light. Trillions of miles away, as it is, it dazzles the eye when seen through a powerful telescope.

NOTE.—The idea of distance is often best conveyed by some every-day illustration. When the poet wrote, "*Sic ilur ad astra*,"—Thus one travels to the stars—he was not thinking of railroads. But they are familiar enough to us. In a lecture by Dr. William Huggens, the eminent English astronomer, as to the results of spectrum analysis as applied to the heavenly bodies, this striking statement was used to give some faint notion of the enormous distance of the stars:

"The earth's orbit," said the lecturer, "which is more than one hundred and ninety million miles in diameter, at most of the stars dwindles to a mere point, and has no sensible size whatever. If you suppose a railroad from the earth to the nearest fixed star, which is supposed to be twenty trillions of miles from us, and if you suppose the price of the fare to be *one penny for every hundred miles*,—not, mind, a penny per mile,—then, if you take a mass of gold to the ticket office equal to the national debt (three billion, eight hundred million dollars), it would not be sufficient to pay for a ticket to the nearest fixed star. And I think I should not be wrong in saying there are stars so far off that, at the price of one penny for every hundred miles, the whole treasure of the earth would not be sufficient to pay for a ticket."

## 62. Do we ever see the stars?

ANS.—We do not. This assertion seems almost paradoxical, but it is strictly true. The stars are so far removed from us that we see only the light they send, but not the surface of the planets themselves.

## 63. How is it that the days and nights are not always equal?

ANS.—The days and nights are equal all over the world

on the 22d of March and the 22d of September, which dates are called the *vernal* and *autumnal equinoxes* for that very reason—*equinox* being the Latin for equal night. If we were living in Greenland at the spring equinox, we should find the Arctic circle half in light and half in shade. One-half of the twenty-four hours (the time of one rotation), therefore, will be spent in sunshine, the other in shade. Gradually, however, as we approach the *summer solstice* (going from left to right), we find the circle coming more and more into the light, in consequence of the inclination of the axis, until, when we arrive at the solstice, in spite of the earth's rotation, *we cannot get out of the light*. At this time, we see the *midnight sun* due north! The sun, in fact, does not set. The solstice passed, we approach the autumnal equinox, when again we shall find the day and night equal, as we did at the vernal equinox. But when we come to the winter solstice, we get no more midnight suns: all the circle is now situated in the shaded portion; hence, again, in spite of the earth's rotation, *we cannot get out of the darkness*, and we do not see the sun even at noonday.

#### 64. To what is the sun's heat equal?

Ans —The heat thrown out from *every square yard* of its surface is as great as that which would be produced by burning six tons of coal on it each hour. The surface of the sun contains 2,284,000,000,000 square miles, and there are 3,097,600 square yards in each square mile. How many tons of coal must be burnt, therefore, in an hour, to represent the sun's heat?

#### 64. To how many full moons is the sun's light equal?

Ans.—It would require 800,000 full moons to produce a day as brilliant as one of cloudless sunshine.

66. What are the three classes of stars in our latitudes?

Ans.—1. Those northern stars which never set (northern circumpolar stars). 2. Those southern stars which never rise (southern circumpolar stars). 3. Those stars which both rise and set.

67. Where is the northern celestial pole?

Ans.—It lies in *Ursæ Minor*, and a star in that constellation very nearly marks the position of the pole, and is therefore called *polaris*, *pole star*, or the *north star*. One of the most striking circumpolar constellations is *Ursæ Major* (the Great Bear) the *Dipper*, the *Plough* or *Charles's Wain*, as it is otherwise called. Two stars in this are called *pointers*, as they point to the pole star, and enable us to find it easily.

NOTE.—The best way to obtain a knowledge of the various constellations and stars is to employ a celestial globe. When the positions of the constellations are thus known some star-map should be referred to, and used in comparison with the sky itself.

68. Name other constellations.

Ans.—The other more important circumpolar constellations are Cassiopea, Cepheus, Cygnus, Draco, Auriga (the brightest star of which, Capella, is very near the horizon when below the pole), and Perseus. The principal southern circumpolar constellations which never rise in this country are Crux, Centaurus, Argo, Lepus, Eridanus, and Dorado.

NOTE.—The apparent movement of the celestial sphere is completed in the same time as the earth's rotation, and if, for instance,



we observe the Great Bear, we shall in six hours see it advance from one of its positions to the next—ninety degrees from the starting point—completing the revolution around the pole star in 24 hours.

69. How do we measure the distance of the sun?

Ans.—Of the two principal methods, one depends on the gravitating force of the sun upon the moon, and the other upon the velocity of light. Now, we know from the phenomenon of aberration that light passes from the sun to the earth in about 498 seconds. If the velocity of light is 186,360 miles per second, the product of these two numbers gives the distance of the sun in miles.

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### Practical Questions.

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Who invented the planisphere? Which is the “Dog-star”? What are the chemical ingredients of the Sun? What is the meaning of planet? of solstice? What is aberration of light? How many moons would it take to make one earth? What is a *digit*? When does the moon become *gibbous*? What is meant by “mean distance”? Define azimuth, declination, and right ascension. What is the synodic period? What occasions the change of seasons? What is meant by the “precession of the equinoxes”? What are the *November showers*? Of what magnitude are the minor planets? What is a vertical circle? When does Venus make its next transit? What words are derived from *τρέπω* (*trepo*) *I change*? What is the meaning of zodiac? To what is the term *via lactea* applied? Describe mutation. What are *faculæ*? A *gnomon* is what? How

determine the latitude by a circumpolar star? What day does the clock measure in twenty-four hours? In what phases of the moon do eclipses of the sun and moon occur? How much higher and how much lower does the moon run than the sun? What were *clepsydræ*? Who was Anaxagoras? What was Kirchoff's theory of the constitution of the sun? When we say "The earth is in Libra," what do we mean? Why can we not see the stars by day as well as by night? Locate seven stars of the first magnitude.



# MYTHOLOGY.



# MYTHOLOGY,

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## 1. What is Mythology?

Ans.—The word mythology is compounded of two Greek words, *μῦθος*, a fable, and *λόγος*, a discourse; and signifies a system of fables, or the fabulous history of the false gods of the heathen world.

## 2. Name its divisions.

Ans.—1. Cosmogony and Theogony. 2. The Gods—Superior and Inferior Deities. 3. The Demi-Gods and Heroes. 4. Mythic Fictions.

NOTE.—By Cosmogony, we understand the legends relating to the creation of the worlds; by Theogony, those relating to the origin of the gods. On both points we have to deal with the Greeks alone, since the Romans never indulged in any researches of this kind. All that their poets have to say on the subject is, without exception, borrowed from the Greeks.

## 3. What was Chaos?

Ans.—Chaos,—dark, unbounded space, containing all the seeds of nature,—was first, according to Hesiod; then from Chaos were produced Earth (Gaea or Ge), Eros (Love), Erebus (Night), and the Universe. Tartarus (the abyss beneath the earth) severed itself. Earth was one of the most ancient oracles and deities in mythology. She pro-



duced Uranus (heaven), the mountains, and Pontus (the sea).

#### 4. Who were the first gods?

ANS.—Those produced of the earth partly by Uranus and partly by Pontus. From her union with Uranus sprang the Titans, the Cyclopes and the Centimanes (hundred handed); from her union with Pontus, various sea deities.

NOTE.—According to some mythologists, Love is of all gods the most ancient, and is said to have existed before all generations, and first incited Chaos to bring forth darkness, out of which sprang Ether and Day—it is said that his union with Chaos gave birth to men and the animals which inhabit the earth;—that even the gods themselves were the offspring of Love, before the foundation of the world.

#### 5. Who were the twelve Titans?

ANS.—Six males—Oceanus, Coeus, Crius, Hyperion, Iapetus, and Cronus; six females—Thia, Rhea, Themis, Mnemosyne, Phoebe and Tethys.

NOTE.—Many marriages took place among the Titans. The numerous sea-nymphs are descended from Oceanus and Tethys; from Hyperion and Thia come the deities of the light—Helios (sun), Selene (moon), and Eos (dawn): from Coeus and Phoebe, the deities of the night—Leto (dark night), and Asteria (starry night.)

#### 6. Describe Nox, or Night.

ANS.—Night covers and conceals, and for this reason she is made the mother of the horrible, as well as of the charming. From uncreated night, Daylight arose, by which all formations are developed, and all creatures enjoy life. She is, likewise, according to some, the mother

enjoy life. She is, likewise, according to some, the mother of the inexorable Parcæ; of the avenging Nemesis, who punishes hidden crime; of the Furies, who torment the wicked; of Charon, the Ferry-man of Hell; and of the twin brothers, Sleep and Death.

NOTE.—She is also the mother of Dreams; of the Hesperides, who guard the golden apples; of Deceit enveloping himself in darkness; of malicious censure; of fretting grief; of trouble and hunger; of destructive war; of duplicity of speech; and, finally, of perjury. Among the children of night are comprised all those things which she conceals; or which Fancy, herself, would fain cover with nocturnal darkness. In night there is something of which even the gods stood in awe, for Homer says: "When Jupiter was angry at the god of 'sleep,' Night covered him with her vail, and the thunderer restrained his wrath, fearing to offend swift Night." (*Iliad* XIV, 256.)

### 7. What was Pan?

ANS.—The Universe; to whom various origins have been given, one of which has already been mentioned. Among the most learned of the ancients, Pan was considered as one of the oldest divinities, and, according to the Egyptians and the most learned of the Grecian sages, he had neither father nor mother, but sprang from Demogorgon (the genius of the earth) at the same instant with the fatal Parcæ.

### 8. What did his figure represent?

ANS.—The universe; and is a delineation of nature and the rough face which it first wore, while his spotted robe of a leopard's skin represents the starry heavens. His person is a compound of various and opposite parts; so is the world;—an all-governing mind and heterogeneous, prolific elements pervade and constitute it.

NOTE.—Pan's symbol of the pipes is most eloquently expressive of Nature's divine, harmonious constitution, and of the order

and measure that govern all her works, producing that solemn movement called the music of the spheres; imperceptible indeed to our material organ, but so delightful and pleasing to the ear of the mind. This wondrous reed on which he incessantly plays is composed of seven pipes, unequal among themselves, but fitted together in such just proportion as to produce the most unerring and melodious notes, calling forth the echo, which poets have made the object of his love. By the Arcadians, he was venerated as the chief of the rural deities. The cause of sudden fright was ascribed to him; hence our word "panic," fear without cause.

*Query.*—What were the mental qualifications of the gods? What was their employment? Who were Mors, Somnus, and Morpheus?

## 9 Who was chief of the celestial deities?

*Ans.*—Zeus (Jupiter) the son of Kronos (Cronus) and Rhea. Uranus, fearing lest his last-born sons, the powerful Cyclopes and Centimanes, might one day seize his power, buried them directly after birth, in the deep abyss beneath the earth. This displeased Gæa, their mother, who thereupon prompted the Titans to conspire against their father, and induced Cronus, the youngest and bravest of them all, to lay violent hands upon Uranus. Uranus was mutilated, cast into chains, and compelled by his sons to abdicate his sovereignty, which now passed to Cronus, but the latter was not long destined to enjoy the fruits of his crime. The curse of Uranus, who prophesied that he would suffer a like fate at the hands of his own son, was fulfilled. So anxious was he to avert such a catastrophe, that he swallowed his children immediately after their birth. Five had already suffered this fate—Hestia, Demeter, Hera, Hades, and Poseidon. But their mother, Rhea, grieved at their lot, determined to rescue her next son, Zeus, by a stratagem. In the place of her child, she gave to her suspicious and cruel husband a stone wrapped in swaddling clothes, which he swallowed with-

out further examination, Zeus, who was thus rescued, was reared by the nymphs in a grotto on Mount Dicte, in Crete. The she-goat Amalthæe served as his nurse, while the bees brought him honey to eat. In order that the cries of the child might not betray his presence to his suspicious father, the Curetes, or attendant friends of Rhea, drowned his voice in the clashing of their weapons. Zeus remained thus hidden until he had become a young but powerful god. He then attacked and overthrew his father Cronus, whom he also compelled, by means of a device of Gæa, to bring forth the children that he had devoured. One part of the Titans submitted without hesitation to this new ruler of the world. The others, refusing allegiance, were after a contest of ten years overthrown by Zeus with the help of the Cyclopes and Centimanes.

### 10. Who were Poseidon and Hades ?

ANS.—The two brothers of Zeus, with whom he shared the empire of the world. The former he made ruler of the ocean and waters; the latter he set over the infernal regions; everything else he retained for himself. The resentment of Gæa, however, led her to produce with Tartarus, her youngest and most powerful son, the giant Typhœus, a monster with a hundred fire-breathing dragons' heads, whom she now sent to overthrow the dominion of Zeus. A great battle took place, which shook heaven and earth. Zeus, by means of his never-ceasing thunder-bolts, at length overcame Typhœus, and cast him into Tartarus, or, according to later writers (Pindar and Virgil), buried him beneath Mount Ætna in Sicily, whence at times he still breathes out fire and flames toward heaven.

NOTE.—Some poets tell of another rebellion, that of the Giants, against Zeus. These are said to have sprung from the drops of blood which fell to the earth from the mutilated body of Uranus.



From the plains of Phlegra, in Thessaly, the land which bears the clearest traces of natural convulsions, they sought to storm Olympus by "*piling Pelion on Ossa*." But after a bloody battle, in which all the gods took part, the two were conquered and sent to share the fate of the vanquished Titans in Tartarus. No hostile attack ever after disturbed the peaceful ease of the inhabitants of Olympus.

### 11. Name the wives of Zeus.

ANS.—The earliest wife was Metis (prudence), the daughter of Oceanus. Zeus devoured her, fearing lest she should bear a son who would deprive him of the empire it had cost him so much to attain. It was soon after this that he produced Pallas Athene (Minerva) from his own head. His second goddess-wife was Themis, one of the Titans, by whom he became the father of the Horæ (Seasons) and the Mœræ (Fates). Dione appears as the wife of Zeus of Dodona, and the mother of Aphrodite (Venus); while Arcadian Zeus was wedded to Maia, by whom he had Hermes (Mercury). By Demeter (Ceres) he became the father of Persephone (Proserphine, the goddess of vegetation); by Eurynome, a daughter of Oceanus, of the Charites (Graces); by Mnemosyne (Memory), of the Muses; by Leto (Latona), of Apollo and Artemis. The youngest of all his divine wives, who was recognized by later mythology as his only legitimate queen, was his sister Hera. By her he became the father of Ares (Mars), Hephæstus (Vulcan), and Hebe.

### 12. Who was Iris?

ANS.—The goddess of the rainbow and the constant attendant of Hera (Juno).

### 13. Give an account of Pluto.

ANS.—Pluto or Hades was the god of the lower regions,



the entrance to which was guarded by the dog Cerberus, "with three heads and a serpent's tail fawning upon those who entered, but showing his horrible teeth to those who tried to pass on." Those who entered the domains of Pluto had to cross the river Styx, and only those whose bodies had been properly buried were ferried across by Charon, the ferryman. He charged a small fee for his services, and a piece of money was always put in the mouth of the dead man to insure his passage across the river. The river Lethe was also said to exist here, whose waters if tasted by any one would cause utter forgetfulness of the past.

*Query.*—Who were the Erinnyes? Name the four rivers of Hades. What was the location of the celebrated gardens of the Hesperides? Who was the god of the smooth sea? The Nereides, or nymphs of the sea, were how many in number? Who was Electra? Who was Proserpina?

#### 14. Who was *clown* among the gods?

Ans.—Momus (Mockery) a son of Night, was the god of raillery and repartee; at the feasts of the gods he played the buffoon. His office was to reprove the faults of the gods, which he did in so sarcastic a manner as to put himself out of favor. He blamed Vulcan, because in the human form which he made of clay, he had not placed a window in the breast, by which whatever was done or thought there might easily be brought to light. He censured the house made by Minerva, because it was not movable, by which means a bad neighborhood might be avoided. For his various illiberal reflections upon the gods, he was finally driven from Heaven. He is generally represented raising a mask from his face, and holding a small figure in his hand.

#### 15. What is the legend of Galatea?

Ans.—She loved Acis, the handsome shepherd, and the monstrous Cyclop, Polyphemos, sued in vain for her favor. On a certain occasion, the monster beheld the nymph at the foot of Mount Aetna embracing his handsome rival. He became distracted with furious jealousy, and, tearing up a rock from its roots, raised it in the air, and hurled it upon the lovers in order to bury them under its weight. The nymph swiftly escaped into the sea, but Acis, overwhelmed by the massive stone, sprang forth from beneath it as a purling brook, the waters of which produced a meandering stream that bore his name.

16. Who were the Grææ (Gray-maids)?

Ans.—Perphredo (horrifier), Enyo (shaker), and Deino, (terrifier), three decrepit virgins, who were gray with age from their very birth. Their abode was at the end of the earth, where reigns eternal night.

17. What was the Sphinx?

Ans.—A monster with the face of a woman, the breast, feet and tail of a lion, and the wings of a bird. Juno, always hostile to the city of Dionysos, sent this monster to ravage the territory of Thebes; She had been taught riddles by the Muses, and from the Phicean Hill propounded one to the Thebans. It was this: "What is that which has one voice, is four-footed, two-footed, and at last three-footed?" The oracle told the Thebans that they would not be delivered from the Sphinx until they had solved the riddle. They often met to try their skill, and, when they failed, the Sphinx carried off and devoured one of their number. At length Haemon, son of Creon, having become her victim, his father, by public proclamation, offered his throne and the hand of his sister, Jocasta, to whoever

should solve the riddle. Aedipus, who was then at Thebes, hearing this, came forward and answered the Sphinx that it was man, who when an infant creeps on all fours; when a man, goes on two feet; and when old, uses a staff, a third foot. The Sphinx then flung herself down to the earth and perished.

*Query.*—Who were the Gorgons? What came from the blood of Medusa? What was the name of the two-headed dog? How was the Chimæra represented? What were the orders of nymphs?

### 18. What tradition had the Greeks?

Ans.—That of a great flood which swept away the whole human race except one pair, Deucalion and his wife Pyrrha, who were preserved and landed on Mount Parnassus when the flood abated. By the direction of Jupiter, he and his wife threw stones behind them, and those which Deucalion threw became men, and those thrown by Pyrrha women.

### 19. Who was the most beautiful of the gods?

Ans.—Apollo. Like other sons of Zeus, he is a god of light, and, indeed, the purest and highest representative of this mighty power in nature. As the bright god of heaven, to whom everything impure and unholy is hateful, we find Apollo, soon after his birth, preparing to do battle with the evil powers of darkness. With his arrows he slew both the giant Tityus and the serpent Python, the latter a monster that inhabited the valley of the Plistus, near Delphi, and destroyed both men and cattle.

### 20. Who was Artemis (Diana)?

Ans.—The feminine counterpart of her twin brother Apollo, with whom she entirely harmonizes when regarded from her physical aspect. Like him, she is a beautiful and

propitious deity; but like him, too, she can deal out, at times, death and destruction among mankind.

21. Who was the god of the sea?

Ans.—Poseidon (Neptune). He is represented as bearing a trident, and driving a chariot with horses over the water. Amphitrite was his wife and the goddess of the sea.

22. Who was the god of war?

Ans.—Mars; who represents war from its fatal and destructive side, by which he is clearly distinguished from Athene, the wise disposer of battles. Homer, in the "Iliad," paints in particularly lively colors the picture of this rude "man-slaying" god of war. He here appears as a deity who delights only in the wild din of battle, and is never weary of strife and slaughter. The usual attendants and servants are Fear and Terror. Popular belief made Mars the father, by a vestal virgin, of Romulus and Remus, the legendary founders of Rome. His wife appears to have been Nerio; but she enjoyed no honors at Rome.

NOTE.—It must be remembered that the Romans adopted from the Greeks the popular conceptions regarding the gods. They transferred existing myths, and fathered them on their own gods and goddesses that bore the closest resemblance to the Greek divinities, and harmonized best with their natural interpretation. Thus it was that the Roman Jupiter was identified with the Greek Zeus, Juno with Hera, Minerva with Athene; though for peculiar deities, such as Janus, they could find no Greek prototype.

23. Who was transformed into a cow?

Ans.—Io; a daughter of Inachos, loved by Jupiter, and persecuted by Juno; who, after her transformation, was furiously driven over the whole earth, until she found a

resting-place in Egypt. There she had a temple erected, and was worshipped as a goddess (Isis). She gave a son to Jupiter, called Epaphos, from whom sprang a royal race, that afterward reigned in Greece, founding their right of royal authority on descent from old Inachos.

*Query.*—From whom is the word “Martial” derived? How many eyes had Argus? Who was Phoroneus? What was the Alpheios? What was the origin of the fountain Arethusa?

## 24. How were the gods punished?

*Ans.*—If any of them were guilty of perjury, Jupiter obliged them to drink of the water of the Styx, which for a whole year lulled them to senseless stupidity, and for the nine following years they were deprived of the nectar and ambrosia of the gods.

## 25. Who was the goddess of love?

*Ans.*—Venus. In the “Iliad,” she is represented as the daughter of Jupiter and Dione, but this account was gradually replaced by another which prevailed among the later poets, who related that she was born of the foam of the sea, and first touched land on the island of Cyprus, which was henceforth held sacred to her. She figured among the Greeks as goddess of beauty and sexual love.

*NOTE.*—The story of her love for the beautiful Adonis is of Asiatic origin, but underwent various alterations on its way through Greece. The germ of the story may be easily distinguished, as it clearly represents the decay of nature in autumn, and its resuscitation in spring. Adonis was killed, when hunting, by a wild boar. Inconsolable at her loss, Venus piteously entreated Father Jove to restore his life. Jupiter at length consented that Adonis should spend one part of the year in the world of shadows, and the other in the upper world.

## 26. Give an account of Mercury.



Ans.—He was born in a grotto of Mount Cyllene, in Arcadia, whence he is called Cyllenius. We know the stories of his youth chiefly from the so-called Homeric Hymn. This relates in a delightful manner how he gave token, soon, after his birth, of his cunning and dexterity, the chief features of his character. Growing in a wonderful manner, as only gods can grow, he sprang, only four hours after his birth, from his mother's lap, and finding a tortoise, he placed strings across its shell, and thus invented the lyre, on which he immediately began to sing the loves of Jupiter and Maia. Then towards evening, impelled by a resistless craving for meat, he hurried to Pieria, where he stole fifty bulls from the herds of Apollo. After killing two of them, and thus satisfying his hunger, he returned to the grotto of his mother and lay down in his cradle as though nothing had happened. Apollo, however, soon remarked the theft, and hurried after the impudent robber. Mercury now played the innocent, and obstinately denied the charge; but Apollo was not to be deceived, and forced the young thief to accompany him to the throne of Jupiter to have their quarrel decided. Jove ordered Mercury to restore the cattle, but Apollo gladly made them over to Mercury on receiving the newly invented pipe. Thus the latter became the god of shepherds and pastures, while Apollo henceforth zealously devoted himself to the art of music. Mercury became afterwards the messenger of the immortals.

## 27. Who was the blacksmith of the gods?

Ans.—Vulcan, the god of fire and the forge, was commonly regarded as a son of Jupiter and Juno. According to Hesiod, he is the son of Juno alone, who in this wished not to be outdone by Zeus, who had produced Minerva from his own brain. He was weak and delicate from his

birth, for which reason he was so disliked by his mother that she flung him from Olympus. He was received by Thetis and Eurynome, and dwelt with them for nine years in a grotto, surrounded by Oceanus. According to later writers, he was educated with the rest of the gods in heaven, and was expelled from Olympus by Jupiter. Juno raised a storm, which drove Hercules out of his course at sea. Jupiter then tied her hands and feet together, and suspended her between heaven and earth. Vulcan attempted to free his mother, and for this act he was kicked down from heaven by his father. The island of Lemnos is said to have received the god.

NOTE.—His first work is said to have been a throne of gold, which he presented to his mother, to avenge himself for her want of affection towards him—upon which Juno was no sooner seated than she found herself unable to move. The gods attempted to set her at liberty by breaking the chains with which she was confined; but to no purpose, as Vulcan alone had the power to unloose them.

## 28. Who was Hestia (Vesta)?

ANS.—The guardian angel of mankind, who guards the security of the dwelling, and is, in consequence, regarded as the goddess of the family hearth, the centre of domestic life. In the temple at Delphi a fire was kept ever burning in honor of Hestia. The character of the goddess was as pure and untarnished as flame itself. Not only did she herself remain a virgin, though wooed by both Neptune and Apollo, but her service could be performed only by chaste virgins.

## 29. What is said of the vestal virgins?

ANS.—The service of Vesta occupied a far more important place in the life of the Romans. Her most ancient temple, which was supposed to have been built by Numa

Pompilius, was situated on the slope of the Palatine opposite the Forum. It was built in a circle, and was of moderate dimensions, being, indeed, little more than a covered fire-place. In it the eternal fire, a symbol of the life of the state, was kept burning. Here, too, the service was performed by virgins, whose number was at first four, but was afterward increased to six. Their chief occupation was to maintain the sacred fire, and to offer up daily prayers at the altar of the goddess for the welfare of the Roman people. The extinction of the sacred flame was esteemed an omen of coming misfortune, and brought severe punishment on the negligent priestess. The choice of vestals lay with the Pontifex Maximus. They were chosen between the ages of six and ten years, always out of the best Roman families. For thirty years they remained bound to their sacred office, during which time they had to preserve the strictest chastity. At the end of this time they returned to civil life, and were permitted to marry if they liked,

30. From what god is the name January derived?

Ans.—From Janus. In Italy, he was usually represented with two faces, one before and one behind, and hence called Bifrons and Biceps. Sometimes he is represented with four faces, and is then called Quadrifrons. There was an ancient statue of this deity in the Forum, said to be as old as the time of Numa, of which the fingers were so formed that those of one hand represented three hundred (CCC), those of the other, fifty-five (LV); the number of the days of the ancient lunar year.

31. Who was Quirinus?

Ans.—A purely Roman divinity. In his symbolic

meaning he bore a great resemblance to Mars. He was the national god of the Sabines, who came to Rome with Titus Tatius.

*Query.*—Which of the goddesses made the chase her favorite amusement? Of what god did the Roman consuls ask a blessing? Who were the Penates? Where were the workshops of Vulcan? Who was the Argus-slayer?

32. Who alone of the secondary deities enjoyed divine honors?

ANS.—Eros (Amor, or Cupid), who was reputed to be the son of Venus and Mars. A boy of wondrous beauty, on the verge of youth, his weapon is a golden bow, with which he shoots forth his arrows from secret lurking-places, with an unfailing effect that represents the sweet but consuming pangs of love.

33. Relate the fable of Cupid and Psyche.

ANS.—The beauty of Psyche aroused the jealousy of Venus, who sent Cupid charged with the mission of inciting her to love some common man. Cupid made the visit, but was so smitten with her beauty that he fell in love with her, and carried her to a fairy palace in the vale of Paradise, where they lived happily. But Psyche was not allowed to behold Cupid with her eyes, and tempted by her sisters to satisfy her curiosity she took a lamp and stole to his bed-side when he was asleep. A drop of hot oil falling from the lamp awakened the god, who charged her with disobedience to his commands and deserted her. Having searched for him long she at last found her way to the palace of Venus, who, after exacting from her various kinds of menial service, ordered her to go to the lower world and bring a box of beauty's ointment from

**Persephone.** On returning and opening the box, she sank overpowered by the odor. Cupid, unable to resist longer, came to her help and brought her back to life. The wrath of Venus was appeased, and Cupid and Psyche were married, the latter obtaining immortality.

**NOTE.**—Psyche signified originally "*the soul*," but came afterward to mean "*a butterfly*," the likeness of the two being not difficult to see. The object of the story seems to be to illustrate the three stages of the soul's existence: its pre-existence in a happy state, its abode on earth with trials and sorrow, and the future state of happy immortality.

### 34. Who was Hymenæus (Hymen)?

**Ans.**—A personification of the joys of marriage; who was, however, only recognized by later writers and by later art. He is portrayed as a beautiful youth, winged like Cupid, but taller, and of a more serious aspect. His indispensable attribute is the marriage torch.

### 35. Name the nine Muses.

**Ans.**—Clio, Melpomene, Terpsichore, Polyhymnia, Thalia, Urania, Euterpe, Erato, and Calliope. Pindar gives the following account of their origin: After the defeat of the Titans, the celestials besought Jupiter to create some beings who might perpetuate in song the mighty deeds of the gods. In answer to this prayer he produced with Mnemosyne the Muses. They sing of the present, the past, and the future, while Apollo's lute accompanies their sweet strains, which gladden the hearts of the gods as they sit assembled in the lofty palace of Father Zeus, in Olympus. Looked at in connection with Nature, there is little doubt but that the Muses were originally nymphs of the fountains. The veneration of the Muses first arose in Pieria, a district on the eastern declivity of Mount Olym-



pus, in Thessaly, from whose steep and rocky heights a number of sweet rippling brooks descend to the plains. The preception of this natural music led at once to a belief in the existence of such song-living goddesses. Their seat was subsequently transferred from the declivities of Olympus to Mount Helicon, in Bœotia, or to Mount Parnassus, at the foot of which the Castalian fountain, which was sacred to them, had its source. Originally the muses were only goddesses of song, though they are sometimes represented with instruments on vases. In early times, too, they only appear as a chorus or company, but at a later period separate functions were assigned to each, as presiding over this, or that, branch of art.

NOTE.—According to the art-distribution, made probably at the time of the Alexandrine school, Calliope represents epic poetry and science generally, her attributes being a roll of parchment and a pen. Clio is the muse of history, and is likewise characterized by a roll and pen, so that it is sometimes difficult to distinguish her from Calliope. Eutherp represents lyric poetry, and is distinguished by her double flute. Melpomene, the muse of tragedy, generally appears with a tragic mask, a club or sword, and a garland of vine-leaves. Terpsichore is the muse of dancing, and has a lyre and plectrum. To Erato is assigned erotic poetry, together with geometry and the mimic art; she generally bears a large stringed instrument. Thalia, the muse of comedy, is distinguished by comic mask, an ivy garland, and a crook. Polyhymnia presides over the graver chant of religious service; she may be recognized by her dress, wrapped closely around her, and her grave, thoughtful countenance, but is without attribute of any kind. Lastly, Urania, the muse of astronomy, holds in one hand a celestial globe, and in the other a small wand.

### 36. Who were the Camenæ?

ANS.—The Romans venerated a number of fountain-nymphs of song and prophecy under this name, among whom the Egeria of the history of Numa is well known.

The Roman writers seem at pleasure to have identified these goddesses with the Muses.

37. What does the name Atlas signify?

ANS.—The Endurer, and Homer calls him *the wise or deep-thinking*, who knows all the depths of the sea, and keeps the large pillars which hold Heaven and Earth asunder. The Atlas of Homer and Hesiod is not the personification of a mountain. In process of time, however, when the meaning of the earlier legend had become obscured or lost, Atlas, the keeper of the pillars that support Heaven, became a mountain of Libya.

NOTE.—According to one mythologist, Atlas was a king of the remotest west, rich in flocks and herds, and master of the trees that bore the golden apples. An ancient prophecy delivered by Themis had announced to him that his precious trees would be plundered by a son of Jupiter. When, therefore, Perseus, on his return from slaying the Gorgon, arrived in the realms of Atlas, and, seeking hospitality, announced himself to be a son of the king of gods, the western monarch, calling to mind the prophecy, attempted to repel him from his doors. Perseus, inferior in strength, displayed the head of Medusa, and the inhospitable monarch was turned into the mountain which still bears his name.

38. What other account is given?

ANS.—That he was a man of Libya, devoted to astronomy. Having ascended a lofty mountain, for the purpose of making observations, he fell into the sea, and both sea and mountain were named after him. His supporting the heavens was usually explained by making him an astronomer and the inventor of the sphere.

39. How was the formation of man accomplished?

ANS.—Prometheus took a piece of earth, a portion of

clay still impregnated with divine particles, moistened it with water, and formed man after the image of the gods; so that he alone raises his look to heaven, while all other creatures bend their eyes to the ground.

NOTE.—Prometheus is said to have been the first to secure the use of fire for mankind, which he succeeded in doing by stealing it from heaven. As a punishment for the theft, he was condemned to be chained alive to a rock in the Caucasus mountains, while every day a vulture came and ate of his liver, which grew again as fast as eaten. Hercules set Prometheus free, and destroyed the vulture that preyed on his liver. Prometheus out of gratitude warned him not to go himself to take the golden apples of the Hesperides, but to send Atlas for them, and in the meantime to support the Heaven in his stead. The hero did as desired, and, at his request, Atlas went to the Hesperides and obtained three apples from there. He then proposed to take them himself to Eurystheus, while Hercules remained to support the sky. At the suggestion of Prometheus, the hero feigned consent, but begged him to take hold of the heavens till he made a pad to put upon his head. Atlas threw down the apples and good-humoredly consented, when Hercules, of course, left him in his former position and made off with the prize.

#### 40. Who was Pandora?

ANS.—When Jupiter descried the light of fire upon the earth, he formed the design of punishing men through their own folly. He therefore requested Vulcan to make a woman of clay, which he intended sending to Prometheus for a wife; he directed him to knead earth and water till it assumed the form of a virgin, like the immortal goddesses, and then to give it human voice and strength. Jupiter also desired Minerva to endow her with artist-knowledge, Venus to give her beauty, and Mercury to inspire her with an impudent and artful disposition. When formed, she was attired by the Seasons and Graces, and each of the deities having bestowed upon her the desired gifts, she was called Pandora (All-gifted). Jupiter then

gave her a beautiful box, which she was ordered to present to the man who married her; and, by the commission of the god, Mercury conducted her to Prometheus. In the box was enclosed the whole train of evils that threaten mankind. Prometheus, aware of the fraud, rejected the dangerous gift, and sent Pandora away without suffering himself to be captivated by her charms.

41. How did the misfortunes appointed to men come upon them?

Ans.—Through the inconsiderate Epimetheus, who, although warned by his brother Prometheus, suffered himself to be captivated by the charms of Pandora, who, after he married her, opened the pernicious box, out of which all imaginable evils spread themselves over the whole earth, inflicting misery upon mankind. Pandora immediately closed it again, but the evils had all escaped, and nothing remained in the box but Hope; who, according to Jupiter's decree, would in time afford some consolation to mortals.

*Query.*—What was the Pyrtaneum? Who erected a temple to Venus Genetrix? How did Rome receive the shield of Mars? What is the Venus of Milo? How high is Mount Olympus? Of what is Nike (Victoria) a personification?

42. Who was Hebe (Juventus)?

Ans.—The cup-bearer of the gods, to whom, at meal, she presents the sweet nectar. It may at first seem strange that the daughter of the greatest of the divinities of Greece (Jove) should be relegated to so inferior a position. This, however, is easily explained by the old patriarchal custom of the Greeks, by which the young unmarried daughters,

even in royal palaces, waited at table on the men of the family and the guests,

43. By whom was she succeeded?

ANS.—By Ganymede, son of Tros, the king of Troy, who was made immortal by Jupiter, and installed as cup bearer of the gods. Neither Homer nor Pindar, however, relates the episode of Jupiter sending his eagle to carry off Ganymede. This is first found in Apollodorus. The Roman poet, Ovid, then went a step farther, and made the ruler of Olympus transform himself into an eagle, in order to carry off his favorite.

44. Who was the god of healing?

ANS.—Asclepius (Æsculapius). The worship of this deity, who was said to be the son of Apollo, appears to have originated in Epidaurus, the seat of his principal shrine, and thence to have become generally diffused. In the year 291 B. C., the Romans, suffering from a severe pestilence which had for years depopulated town and county, consulted the Sibylline books, which recommended that Æsculapius should be brought to Rome. The story goes that the sacred serpent of the god followed the Roman ambassadors of its own accord, and chose for its abode the *Insula Tiberina* at Rome, where a temple was at once erected to Æsculapius.

45. Who was the god of wine and debauchery?

ANS.—Dionysus, or Bacchus (Liber); who, growing up amidst the solitude of the forest and strengthening himself by his contests with its wild beasts, at length planted



the vine. Both the god and his attendants soon became intoxicated with its juice; after which, crowned with wreaths of laurel and ivy, and accompanied by a crowd of nymphs, satyrs, and fawns, he ranged the woods, which resounded with the loud and joyful cries of his inspired worshippers. The legend says his education was then completed by Silenus, the son of Pan.

46. What is the story of Ariadne?

ANS.—She was the daughter of Minos, king of Crete. The Attic hero, Theseus, after escaping the dangers of the Labyrinth by her means, had taken her away with him from Crete in order to marry her. He deserted her, however, while asleep on the island of Naxos, either of his own accord, or because warned of the god in his dream. The indescribable anguish and consternation of Ariadne, on awakening to find herself alone and deserted on a foreign strand, were only equalled by her joyous surprise when Bacchus, returning from his travels in India, found her and made her his bride.

*Query.*—Who was Cybele? What is the story of her favorite, Attis? Who obtained divine rank by a leap into the sea? How did Glaucus become a god? What were Dryads and Satyrs?

47. Name the pastoral goddesses.

ANS.—Vertumnus, the self-changing one; Pomona, the goddess of the fruit harvest; Pales, venerated by the shepherds; Terminus, who presided over boundaries; Ceres, patroness of all the arts connected with agriculture; and Persephone, who may be regarded as a type of the grain.

48. Who was Tantalos (Tantalus)?

ANS.—King of Phrygia, who, offending the gods by

his overbearing and treacherous conduct and the cruelty he practised on his own son, was doomed in Tartarus to stand in water up to his throat, while he could not stoop to quench his burning thirst, and to have luscious fruit hang over his head which he could not reach, though suffering with constant hunger. The real significance and force of the word *tantalize* thus appears.

#### 49. What is the story of Ixion?

Ans.—A king of Thessaly, who, for an unnatural crime, was banished from the society of mankind to the realms of Jupiter, where he made an attack upon the virtue of Juno. The angered gods seized him, and Mercury bound him upon the everlasting wheel over the abyss of Tartarus, and then compelled him to consort with the Magnesian mares on the planes of Pelion. Here was born the giant Centaurus, from whom a race of Centaurs filled the earth. Half horse, half man, the world trembled at their daring. Aesculapius was one of their students.

#### IXION.

Permitted with the feasting gods to sit,  
The bright, sun-clad, inflaming scene  
Within his blood the fires of passion lit,  
He dared to love Jove's queen.

Smitten with thunder, hurled from heaven's height  
Headlong to hell—him Hermes bound  
Upon the wheel, which through eternal night  
Circles its restless round.

A myth symbolic, living from the old,  
Voicing through time, the well-earned fate  
Of him, who, spurning charms of mortal mould,  
Would with a goddess mate.

A. P. S.

50. What other celebrated criminals were there?

Ans.—Tityus, who, offering violence to Leto, was chained to the earth, while two vultures continually gnawed at his ever-growing liver. Sisyphus, formerly king of Corinth, had provoked the wrath of the gods by his numerous crimes, and was condemned, in consequence, to roll a block of stone up a high mountain, which, on reaching the top, always rolled down again to the plain. The Danaids, or daughters of Danaus, were condemned to pour water continually into a sack full of holes, which never could be filled, for killing their husbands on the wedding night.

### 51. What was the Palladium?

Ans.—A small wooden image of Pallas (Minerva) which originally fell from heaven upon the city of Troy. Upon the capture of that city, it was carried to Greece, and from thence to Rome. The safety and existence of the Roman Empire, they thought, depended upon the preservation of this figure.

### 52. Who was Proteus?

Ans.—A sea-deity who could assume any form at pleasure, changing himself into fire or water, plant or animal, which rendered him difficult of access; and sometimes, when consulted, he evaded an answer by a sudden metamorphosis. To those only who held him fast with vigorous arms did he appear in his real character, and by his spirit of divination reveal to them the truth.

### 53. For what is Amphiion celebrated?

Ans.—The melancholy fate of his sons and daughters. He married Niobe, the daughter of the Phrygian king,

Tantalus, and sister of Pelops. The heart of Niobe was lifted up with pride at the number of her children,\* and she ventured to prefer herself to Leto, who had only two; she even went so far as to forbid the Thebans to offer sacrifice to Leto and her children, and to claim these honors herself. The vengeance of the offended deities, however, now overtook her, and all her children were laid low in one day before the unerring arrows of Apollo and his sister. The parents did not survive this deep affliction. Amphion slew himself, and Niobe, already paralyzed with grief, was turned into stone by the pity of the gods, and transferred to her old Phrygian home on Mount Sipylus, though even the stone has not ceased to weep.

54. Who was the goddess of three faces?

ANS.—Hecate; who was supposed to preside over all nocturnal horrors, and not only to haunt the tombs and cross-roads herself in company with the spirits of the dead, but also to send nightly phantoms from the lower world, such as the man-eating spectre Empusa, and other fabulous goblins.

55. Who were Thanatus and Hypnos?

ANS.—The twin brothers Death and Sleep. The Romans had a personal god of death, whom they called Orcus; he was represented as an armed warrior dealing out mortal wounds among mankind.

56. What was Actæon's transformation?

ANS.—Into a stag; changed by Artemis while hunting

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\*Homer gives her six sons, and as many daughters; Hesiod and Pindar, ten sons, and ten daughters; but the most common account allows her fourteen children.

one day on Mount Cithæron, and torn into pieces by his dogs. The cause of her anger was either that he had boasted that he was a more skilful hunter than Artemis, or, according to the tradition that ultimately prevailed, that he had surprised the virgin goddess bathing.

57. What is the fable of Narcissus?

ANS.—Echo, a Boetian nymph, was consumed by love for the beautiful youth Narcissus, a son of the river-god Cephissus, and finding that he did not reciprocate her affection, she pined away until nothing was left of her but her voice, which occupied itself in mocking everything it heard. Venus revenged this injury to her sex by causing Narcissus to fall in love with his own image, which he saw reflected in the water, while bending down to quench his thirst from a spring as clear as crystal. He, too, pined away from grief, and was punished by being changed into the flower which bears his name.

58. Relate the fiction of Phaeton (Phaethon).

ANS.—He was the son of Helios and the ocean-nymph Clymene. Venus intrusted him with the care of one of her temples. This distinguished favor of the goddess rendered him so vain and aspiring that Epaphos, to check his pride, disputed his claims to a celestial origin. Phaeton, to refute this bitter reproach, resolved to know his true origin; and, at the instigation of his mother, visited the palace of the Sun, to beg that Helios, if he really were his father, would give him some proof of his paternal tenderness, and convince the world of his legitimacy. Helios swore by the Styx that he would grant him whatever he required. The ambitious youth instantly demanded permission to guide the solar chariot for one day, in order to prove himself the undoubted progeny of the Sun-god. Not



daring to violate the oath by Styx, and finding entreaties and remonstrances unavailing to persuade him from his perilous enterprise, Helios complied with his wish, and Phaeton mounted the chariot of the Sun. The result was that the celestial coursers, guided by a feebler hand than that of Helios, ran a zigzag course towards the heavens and earth, causing the mountains to blaze and the rivers to dry up, and when Earth in her extremity besought Jupiter for help, the king of gods struck Phaeton with one of his thunderbolts, precipitating him into the river Eridanos.

### 59. Who was Orpheus?

Ans.—The son of Apollo and the muse Calliope. His wife, a nymph named Eurydice, died from the bite of a serpent. Orpheus, disconsolate at her loss, determined to descend to the lower world, and obtain permission for his beloved Eurydice to return to the regions of light. Armed only with his lyre, he entered the realms of Hades, and gained an easy admittance to the palace of Pluto. At the music of his "golden shell," to borrow the beautiful language of ancient poetry, the wheel of Ixion stopped, Tantalus forgot the thirst that tormented him, the Vulture ceased to prey on the vitals of Tityus, and Pluto and Proserpina lent a favoring ear to his prayer. Eurydice was released on condition that Orpheus should not look back on her till he reached the upper world. Orpheus, however, violated this condition, and Eurydice was once more lost to him. He himself, not long afterward, while wandering in his despair over the Thracian mountains, was torn in pieces by some women in the mad excitement of their nightly Bacchanalian orgies.

### ENDYMION.

As once on the mountains, dreaming,  
Endymion lay at night,

Dian, while stars were gleaming,  
Looked from the realms of light;  
Looked, and swiftly descending,  
(Her mission of joy and bliss)  
Over the shepherd bending,  
Wakened him with a kiss.

60. What was Grimalkin?

Ans.—A cat; changed by Venus into a beautiful woman at the wish of a devoted lover. While in the embraces of her husband, upon seeing a rat, she immediately jumped from the bed and, the feline nature asserting itself, pursued the animal.

61. Why has the river Pactolus golden sands?

Ans.—Pan, the favorite of the Phrygian King, Midas, wished to compete with Apollo in the art of which the latter was master. Pan commenced the contest, and Midas repeated his songs with enthusiasm, regardless of his celestial rival, when, to his surprise, Midas felt a pair of ears, long and shaggy, pressing through his hair. Alarmed at this phenomenon, Pan fled. Midas made his wife the confidant of his misfortune, and she, longing to tell the secret but daring not, for fear of punishment, sought a retired and lonely spot, where she threw herself upon the ground and whispered, "King Midas has the ears of an ass;" and the reeds that arose in this place repeated as the wind passed through them, "King Midas has the ears of an ass." Enraged and terrified, the king sacrificed to Bacchus, who, to console him, desired him to ask whatever he wished. According to his desire, everything he touched turned to gold, even his food and drink. He then prayed to Bacchus for deliverance from this plague, and, directed by the god to wash in the river Pactolus, gave to that stream golden sands.

62. What is the fable of Cymon and Iphigenia?

ANS.—It simply relates how, under the accidental influence of female charms, Cymon's character is gradually moulded, and from a rough boar he is transformed into a gentleman of elegant manners and delicate feelings.

63. What trial of valor was assigned Bellerophon?

ANS.—The destruction of the fire-vomiting Chimæra, who had the head of a lion, the body of a goat, and the tail of a dragon. To this bold adventure the gods lent their assistance, granting him the winged horse Pegasus. The hero bestrode him, and then in the air commenced the fight. The monster defended herself to the utmost, sending from her mouth whole masses of fire, and coiling her dragon tail in formidable windings. But after a persevering and obstinate struggle, the monster lay stretched on the ground, weltering in her blood. Yet the happiness of the hero was of short duration; for when, elated by this and other victories, he attempted by means of Pegasus to ascend to Heaven, Jupiter, incensed at his boldness, sent an insect to sting the steed, which made Pegasus bound so furiously in the air as to throw his rider to the earth, where he wandered in solitude and melancholy until death relieved him of his fate.

64. What is the fiction of Atalanta?

ANS.—She first distinguished herself in the *Calydonian hunt*, and, at the funeral games of Pelias, won the prize in wrestling. Her father wished her to marry, to which she consented, on condition that her suitors should run a

race with her, promising, if she should be vanquished, to become wife of the victor; but the vanquished suitor should be shot by one of her own darts. As she was almost invincible in running, many of her suitors perished in the contest. Hippomenes, however, imploring the assistance of Venus before venturing to enter upon this dangerous race, received from her three golden apples which, one after another, he let slip from his hand during the course. Atalanta, whose eyes were dazzled by the glitter and beauty of this golden fruit, repeatedly stopped to take it up from the ground, and thus Hippomenes gained time to reach the goal before her.

NOTE.—Hippomenes thus gained the maid of the chase, but unmindful of the benefit which he owed to the goddess of love, both were obliged to atone for his offence against Venus. Profaning a sanctuary of Cybele,—upon the impulse of Venus,—they were transformed into two lions, that under one yoke drew the chariot of Cybele.

### 65. What were the twelve labors of Hercules?

ANS.—Hercules was the son of Jupiter by Alcmena, and was destined by the god to occupy the throne of Perseus, but by the contrivance of Juno was superseded by Eurystheus, whom he was ordered to serve twelve years; but was promised that after he had achieved twelve great works he should be translated to the gods. The labors are enumerated as follows: 1. The fight with the Nemean lion, which he attacked with a club, and finally strangled, bringing the carcass to Mycenæ. He afterward used the head of the lion as a helmet, and the impenetrable skin as a defence. 2. The destruction of the Lernaean hydra, which had nine heads, eight mortal and one immortal. As each head was crushed, two new ones sprang up, until his companion, Iolaüs, seared the necks with burning brands, which prevented the growth of new heads. He then



dipped his arrows in its gall, thus rendering the wounds inflicted by them incurable. 3. The capture of the Erymanthean boar, which he chased up to the snow-covered summit of a mountain, and then caught alive. 4. The capture of the Stag of Diana, famous for its swiftness, golden horns and brazen hoofs. He pursued it for a year, and at length, wounding it with an arrow, caught it. 5. The killing of the Stymphalides, or carnivorous birds, which ravaged the country, feeding on human flesh. He startled them with his rattle of brass, and shot *most* of them, as they were flying away. 6. Cleaning the Augean stables, where 3,000 oxen had been kept for 30 years. This he accomplished in a single day, by turning the river Alpheus, or Peneus, through the stable. 6. The capture of the wild bull of Crete. 8. The abduction of the four mares of Diomedes, king of the Bistones, a warlike tribe of Thrace. He slew Diomedes, and threw his body to the mares, which became tame after eating their late master. 9. The seizure of the girdle of Hippolyte, queen of the Amazons. 10. The capture of the oxen of Geryones, a monster who lived in the island of Erythia, which were guarded by the giant herdsman, Eurytion, and the two-headed dog Orthrus. 11. Seizing the golden apples of the Hesperides. 12. The capture of Cerberus, the three-headed dog that guarded the entrance to Hades. Pluto consented to his taking Cerberus, on condition that he should master him without using any weapons. Hercules seized the furious beast, chained him, choked him into submission, and, after showing him to Eurystheus, carried him back to his place in the lower world.

66. Who is the Jupiter of the Norse Mythology?

Ans.—Odin, or Wodin; from whose name we get our



word Wednesday—Wodin's day. From the name of his wife, Frigga (Venus), we derive the word Friday.

67. Who was Thor (Donar)?

ANS.—The eldest son of Odin, surnamed the "Thunderer" who is represented as driving through the clouds in a car drawn by two goats, and holding a hammer in his hand. From his name we obtain the word Thursday.

NOTE.—In Norse mythology, Balder was called the "shining god." Loki was the spirit of evil. Valhalla was the banquet hall; and there were *elves*, *giants*, and *dwarfs*.

68. Who compose the Hindoo trinity?

ANS.—Brahma, Vishnu, and Siva.

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Mythologique.

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What were Scylla and Charybdis? Who was Circe? Who was the Vedic god, Dyaus? What is the Phoenix? Who were the minor deities, Veritas, Virtus, Honos, Pax, Fidelitas, Felicitas, and Amicitia? What is the history of Perseus? Who wore a snake necklace? What were the labors of Theseus? Who were Castor and Pollux? How did Jason obtain the golden fleece? Who founded Thebes? What became of Semele, the mother of Bacchus? Who were the Amazons? How did Odysseus succeed in passing the Sirens? What was the fate of Laocoön, the Trojan priest of Apollo? Whom did Zeus change into a nightingale? How was Dirce punished? The word "*mercenary*" is derived from what? What are the attributes of Minerva? Who had his ears licked by serpents while asleep? What maid was changed into a spider? What were the Eleusi-

nean Mysteries? Have you read Saxe's "Pyramus and Thisbe"? What were the Lares? Whose sons were 9 cubits in width and 9 fathoms in height? How was Orestes punished? What pious couple was changed into an oak and a lime? What is the fiction of Leto and the frogs? What is the Salamander? How did Achilles receive a fatal wound in the heel? How did Penelope keep her suitors waiting? Caledonian hunt? Praxiteles? Triton? Herse? Origin of Ursa Major? Who was Medea? What was the *insula*?





# RHETORIC AND COMPOSITION.





# RHETORIC AND COMPOSITION.

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## 1. What is Rhetoric?

ANS.—It is the science which treats of discourse; and by discourse is meant any expression of thought by means of language. Discourse may be either oral or written.

NOTE.—Rhetoric in its primary signification referred solely to the art of oratory, as is shown in the etymology of the word, the original Greek *ῥητορικὴ* (rhetorike) meaning the art of speaking, from the verb *ῥέω* (rheo) to speak.

## 2. What are the divisions of Rhetoric?

ANS.—Two; Style and Invention.

NOTE.—Rhetoric may be regarded as both a science and an art. As a science, it investigates, analyzes, and defines the principles of good writing; as an art, it enables us to apply these principles, or, in other words, teaches us the best method of communicating our thoughts.

## 3. Define Style.

ANS.—It is that part of Rhetoric which treats of the mode of expression. The word Style comes from the Latin *stylus*, a small steel instrument used by the Romans for writing on waxen tablets. The *stylus* was to the Roman writer what the pen is to us, and became, by an easy metaphor, the means of expressing any oral method of composition, just as we now, by a like metaphor, speak

of a gifted pen, a ready pen, meaning thereby a gifted or a ready author.

4. What topics are included in Style?

Ans.—1, Punctuation and Capitals; 2, Diction; 3, Sentences; 4, Figures; 5, Special Properties of Style; 6, Versification; 7, Poetry; 8, Prose Composition.

5. Discriminate between Grammar and Rhetoric?

Ans.—Any verbal expression of thought, even in its lowest and plainest forms, brings us within the domain of Grammar. But, beyond the bare expression of the meaning, we can conceive of it as being uttered awkwardly or elegantly, plainly or figuratively, concisely or diffusely, and in a great variety of other ways; and the consideration of these various methods of expression takes us at once beyond the region of Grammar, and brings into that of Rhetoric.

NOTE.—Rhetoric is closely allied, on the one side, to Grammar, which determines the laws of language, and, on the other, to Logic, which determines the laws of thought. An expression may violate no rule, either of Grammar or of Logic, and yet be rhetorically incorrect.

6. How may *taste* be defined?

Ans.—As “the power of receiving pleasure from the beauties of nature and of art.” Its characters are *delicacy* and *correctness*. It is a faculty common in some degree to all men. It may be improved by study, comparison, observation, and discussion.

Query.—For what end do we study Rhetoric? What is the best style? Give five rules for using capital letters correctly. Give a

general rule for the use of the comma, colon, and semicolon. Rewrite the following selection, restoring capitals and punctuation marks:—

know then this truth enough for man to know  
virtue alone is happiness below pope

7. What term do the French apply to rhetoric and kindred branches?

Ans.—*Belles-lettres*. At the Lyceum of Arts in Paris, this department comprehends general grammar, languages, rhetoric, geography, history, antiquities, and mathematics. In America, the term is generally used in a more limited sense, to denote polite literature, including criticism, taste, the pleasures of the imagination, etc.

8. What is Criticism?

Ans.—*The art of judging with propriety* concerning any object or combination of objects. Every branch of literary study, as well as each of the arts, has its proper criticism.

9. What advantages are gained by the study of Rhetoric?

Ans.—First, it enables us to discern faults and beauties in the compositions of others; and secondly, it teaches us how to express and embellish our own thoughts, so as to produce the most forcible impression.

10. Give an analysis of the English language.

Ans.—The Saxon words on any page of ordinary English will be found to be nearly nine-tenths of the whole number. The Norman-French words introduced into English after the Conquest are generally words of Latin

origin. Many modern French words, such as *depot*, *bouquet*, *romance*, etc., have become by common consent incorporated into our language. Latin words and phrases are common, introduced through the medium of scholars and educated men. The Celtic elements are prominent in such examples as *tartan*, *plaid*, *flannel*, etc, and new discoveries of science having rendered an enlargement of our technical nomenclature necessary, recourse was had to the Greek, as illustrated in the words *telephone*, *phenomenon*, and the numerous endings in *logy* and *graphy*, and their numerous derivatives. Almost every known language has its representation in our language by one or more words.

NOTE.—The original language of Britain, the old British or Celtic language, that which was spoken by the half-naked savages that Cæsar saw, still exists. It is a living, spoken language. But it is not our language. Though spoken in parts of England, it is not the English language. Englishmen and Americans are lineal descendants of the Anglo-Saxons, and our language is the Saxon language.

11. What are the seven groups of language?

Ans.—1. The Indic, or the languages of India. The ancient original language of India is the Sanskrit, which ceased to be a spoken language at least 300 B. C. 2. The Iranic, the language of Iran, or Persia. 3, The Celtic. 4, The Italic. 5, The Hellenic. 6, The Teutonic. 7, The Slavonic.

Query.—These seven groups form what family? Name some of the modern dialects of the Indic. From what source are the following words derived: *Alcohol*, *rattan*, *chintz*, *coffee*, *czar*, *nankeen*, *caravan*, *squaw*, and *virtuoso*? In what book do we find written the purest Saxon? What does the term alphabet signify, and from what is it derived?

12. Who first introduced the mode of writing from left to right?

ANS.—The Phœnician language was written from right to left. The Greek at first followed it in this respect, but was in course of time written from right to left, and from left to right, alternately, as land is ploughed. The laws of Solon were engraved in this style, about 600 B. C., as also many inscriptions still to be seen on ancient monuments. Soon after this period, however, the present manner of writing, from left to right, came into general use. It had been introduced many years before by Pin-darus, who, according to some, was a teacher of Homer.

### 13. How have rules in Rhetoric been formed?

ANS.—From examination and comparison of those great productions which in all ages have elicited the admiration of men. Thus Aristotle, who was the first to lay down rules for unity of action in dramatic and epic poetry, did not arrive at them by a train of inductive reasoning, but by close observation of Sophocles and Homer.

### 14. What is Diction?

ANS.—It is that part of Rhetoric which treats of the selection and the right use of words. The importance of having a great number of words at one's command cannot be over-stated. Some persons have by nature a special talent for this species of acquisition. An acquired talent is to be obtained only by an enlarged course of reading, by habits of observation in regard to words met with, and by linguistic studies.

### 15. What are the divisions of this subject?

ANS.—Purity, Propriety and Precision. The only standard of purity is the practice of the best writers and speakers. A violation of this standard is called a *Barbarism*.



**Query.**—What are *obsolete* words? What is meant by suspended animation of words? What is meant by *florid*, *nervous*, or *labored* style? Of what kind of style is the following an example?

Beside yon straggling fence that skirts the way  
With blossomed furze unprofitably gay;  
There, in his noisy mansion, skilled to rule,  
The village master taught his little school.

## 16. What is the law of verbal formation?

**Ans.**—That the component parts of a word should be of similar linguistic formation. This rule is violated when a word is made up of two parts, one of which is Saxon, the other Greek or Latin.

**NOTE.**—The termination *-ity*, which is of Latin origin, corresponds in meaning to the termination *-ness*, which is Saxon. *Itty* should therefore be used in making words from Latin stems: *ness*, in forming words from Saxon stems. *Telegraph* is legitimate, but *cablegraph* is barbarous. Which of the following are pure? *Gal-lantness*, *fastly*, *obligate*, *walkist*, *converser*, *preventative*, *incertain*.

## 17. What is the safest plan in regard to new words?

**Ans.**—That stated by Pope in his *Essay on Criticism*—

“In words, as fashions, the same rule will hold,  
Alike fantastic, if too new or old;  
*Be not the first by whom the new is tried,*  
*Nor yet the last to lay the old aside.”*

## 18. What is Campbell's Law?

**Ans.**—The **USE** which determines authoritatively whether a word is legitimate must have these three marks: 1, It must be **REPUTABLE**, or that of educated people, as opposed to that of the ignorant and vulgar; 2, It must be **NATIONAL**, as opposed to what is either local or technical; 3, It must be **PRESENT**, as opposed to what is obsolete.

**NOTE.**—In former years, there was a passion for Latin, as there is at present a great fondness for French; and Gallicisms, or words and idioms from this language, are abundantly interspersed in the current compositions of the day. But all this is wholly unnecessary, and savors of pedantry and affectation.

19. What is the difference between purity and propriety?

**ANS.**—Purity of diction refers simply to the question whether a word is, or is not, in good and current use, as an established part of the language; but propriety asks whether the word is used correctly in the sentence in which it occurs; that is, does it express the meaning of the writer.

**NOTE.**—A constant use of the Dictionary and observation of the way in which words are used by good authors are the proper methods of obtaining propriety of diction. Words change from their original and etymological meaning, as illustrated in the case of *liquidate*, which *once* meant “to meet,” whereas it now means “to pay a debt.”

*Query.*—What distinction should be observed in the use of *falseness*, *falsity*, and *falsehood*? Are husband and wife a *married couple*? What are *solecisms*, *vulgarisms*, *colloquialisms*, *provincialisms*, and *technical terms*? What are *synonyms*?

20. Define Precision.

**ANS.**—That property of style which consists in the use of such words as exactly convey the meaning. The term is derived from the Latin *præcidere*, *to cut off*, which shows how it is used. This can be very forcibly illustrated by the different uses of *surprise*, *astonish*, *amaze*, and *confound*. Make the necessary alterations in the following by striking out the offending word:—M. D.’s death has left a (vacant or empty) seat in the House.—Lemons are (healthy

or healthful).—He has eaten (enough or sufficient) and must go.—Morse (invented or discovered) the telegraph.

NOTE.—Some rhetoricians use a fourth division of style called Perspicuity, which, to a certain extent, involves the three already considered. Its purpose is to distinctly indicate the meaning of the writer or speaker.

21. What are the faults opposed to Perspicuity?

ANS.—Obscurity, Equivocation, and Ambiguity. The first is the result of a variety of causes, such as an improper ellipsis, bad arrangement, complicated sentential structure, the use of technical terms, etc.

22. What is a Sentence?

ANS.—Aristotle's definition is, "A form of a speech which hath a beginning and an end within itself, and is of such a length as to be easily comprehended at once."

23. What is the Rhetorical Classification of sentences?

ANS.—They are divided into Periodic, Loose, Balanced, Short, and Long. A periodic sentence is one in which the several members are linked together, and hang upon one another so that the sense of the whole is not brought out till the close. A *loose* sentence is one where the sense is formed into short independent propositions, each complete within itself. A *balanced* sentence is one containing two clauses which are similar in form and to some extent contrasted in meaning. The terms *short* and *long* are self-explanatory.

24. Give examples of these five classes.

Ans.—“If you look about you, and consider the lives of others as well as your own; if you think how few are born with honor, and how many die without name or children; how little beauty we see, and how few friends we hear of, how many diseases, and how much poverty there is in the world; you will fall down upon your knees, and, instead of repining at one affliction, will admire so many blessings which you have received from the hand of God.”

2. We came to our journey's end, | at last, | with no small difficulty, | after much fatigue, | through deep roads, | and bad weather. 3. Worth makes the man, the want of it the fellow. 4 and 5 unnoted.

25. How is clearness in the construction of sentences to be attained?

Ans.—By avoiding ambiguity, which is often produced by the improper position of the adverb and adverbial clauses and adjuncts. Notice the following inaccuracy of Dean Swift. “Many act so directly contrary to this method that, from a habit of saving time and paper, which they acquired at the university, they write in so diminutive a manner, that they can hardly read what they have written.” He certainly did not mean that they had acquired time and paper at the university, but that they had acquired this habit there.

Make the necessary corrections in the following sentences: “A purse was lost in the street which contained money.” “I only bring forward some things.” “We hope you are and will succeed in your work.” “Keats, a little before he died, said, ‘I feel the daisies growing over me.’” “He called to John mildly.” “I do not mean the bulk only of any single object.” “Thus I have fairly given you, Sir, my own opinion, as well as that of a great majority of both houses here, relating to this weighty

affair; upon which I am confident you may securely reckon."

26. What is meant by *squinting construction*?

ANS.—A word or grammatical expression, thrown into the middle of a sentence, in such a place that it looks both ways; that is, it can be connected in meaning either with what goes before, or with what follows. Ex.—“When I hear a person use a queer expression, or pronounce a name *in reading* differently from his neighbors, it always goes down, in my estimate of him, with a minus sign before it.”—*Dean Alford*.

27. How else may the arrangement of sentences be faulty?

ANS.—From the effect of bad construction, which does not help so much to make the sentence ambiguous as to render it obscure.

Query.—What is the fault in the sentence, “He was exceedingly beloved both by King William and Mary, who nominated Dr. Tenison, Bishop of London, to succeed him”? What is Quintilian’s Rule? What is Blair’s Remark in regard to such adverbs as *only, wholly, at least*?

28. What are the two main parts of the sentence?

ANS.—The Principal Subject and the Principal Predicate. The principal subject is mainly that about which the writer intends to say something. It is not necessarily the grammatical subject, though ordinarily the two are the same.

NOTE.—The most common and natural place for this subject



is at the beginning of the sentence, but there may be cases in which the sense is rendered more striking by placing the subject at the end. One of the common contrivances for producing inversion is the use of the expletives *there* and *it*. Qualifying clauses and adjuncts may sometimes precede the subject without affecting its prominence; e. g., "In the vacant space between Persia, Syria, Egypt and Ethiopia, *the Arabian peninsula* may be conceived as a triangle of spacious but irregular dimensions."

## 29. Where should the Principal Predicate be placed ?

ANS.—No definite rule can be given, prescribing when the predicate should be placed at the beginning, the end, or elsewhere. It requires in each case the exercise of taste and judgment, the writer ever bearing in mind which words constitute the leading subject and predicate, and so arranging the subordinate matter as to make these words prominent.

NOTE.—The words constituting the principal predicate should be placed where they will receive natural emphasis. The sentence "That our elder writers, to Jeremy Taylor inclusive, quoted to excess, it would be the blindness of partiality to deny," should be arranged thus, "It would be the blindness of partiality to deny that our elder writers, to Jeremy Taylor inclusive, are quoted to excess," placing the principal predicate where it would be difficult for a reader not to make it emphatic.

## 30. What is meant by Unity ?

ANS.—It consists in the restriction of a sentence to one leading proposition, modified only by such accessories as are materially and closely connected with it. The first requirement is that during the course of the sentence the scene and the subject be changed as little as possible; the second, that one sentence should not be crowded into another; the third, that a sentence should not be complicated by hanging a relative clause upon another relative

clause which is itself in a dependent position; the fourth is, to avoid parenthesis; and the fifth, not to add a supplementary clause after the sentence has been apparently brought to a close.

31. Give an illustration of violations of the third and fifth requirements.

ANS.—3: "Cicero was opposed by a new and cruel affliction, the death of his beloved daughter Tullia; *which* happened soon after her divorce from Dolabella; *whose* manners and humors were entirely disagreeable to him." 5. With Cicero's writings, young divines are more conversant than with those of Demosthenes, who, by many degrees, excelled the other: "*at least as an orator.*"

32. Define Strength.

ANS.—This quality is variously designated as energy, animation, vividness, etc., but it consists of such use and arrangement of words as make a deep impression on the mind of the reader or hearer.

33. How is a sentence made stronger?

ANS.—By leaving out redundant words. It may be taken for granted, that whatever in a sentence does not add to the meaning enfeebles it. Every redundant word is so much dead weight.

34. Illustrate redundancy.

ANS.—"There is nothing which disgusts us sooner than the empty pomp of language." "To return" is "to go back." The expression, "returning *back*," is therefore re-

dundant. "Good satisfaction!" as if satisfaction was not good.

NOTE.—Our authors copying from Blair claim that the expressions, "The man I love," "The dominions we possessed," err in the opposite direction, *i. e.*, that the relative should be supplied; but as these expressions are intelligible and decidedly poetical, we consider them an allowable form of ellipsis.

35. What is said of the use of "intensive expressions?"

ANS.—A sentence is made stronger by avoiding the too frequent use of *very*, and of other superlative expressions. A *feeble* effusion would read as follows: The emotion *most* certainly is *extremely* delightful, but *still* it is altogether of a *very* serious and *solemn* kind.

NOTE.—Avoid concluding sentences with the prepositions *of*, *to*, *from*, *with*, *by*. Grammar tell us that such expressions are inelegant; they are decidedly unrhctorical. "Which house do you live in?" should be "In which house do you live?" "Avarice is a crime which wise men are often guilty of" is properly rendered, "Avarice is a crime of which wise men are often guilty." Yet in familiar discourse such expressions must occasionally be admitted, to prevent a feeling of constraint in style.

36. What is "splitting particles?"

ANS.—It consists in separating a preposition from the noun which it governs. Ex. He took it from, and would not return it to, the child. It is a violent separation of things which ought to be clearly united, and results in producing an unsatisfied and displeased feeling.

NOTE.—Considerable skill is needed in the management of *and*, for from its use arises the *apparent paradox* that while the object of the conjunction is to join words together, so as to make their connection more close, yet we often effect a closer connection by omitting the connecting word. On the other hand, when

the writer wishes us to rest a moment on each item in an enumeration of particulars, the conjunction is repeated after each. A similar effect is produced by the repetition of *or* and *nor*.

Drills: In the following sentences, make such corrections and alterations as are necessary: "Alfred the Great, of England, was one of the most remarkable and distinguished men that we read of in history."—"Destitute of principle, he regarded neither his family, nor his friends, nor his reputation."—"Censure is a tax for which a man pays the public for being eminent."—"It was a case of unpardonable breach of trust and gross disregard of official duty, to say the least."

### 37. What is Climax ?

Ans.—It is the arrangement of a succession of words, clauses, members, or sentences, in such a way that the weakest may stand first, and that each in turn, to the end of the sentence, may rise in importance, and make a deeper impression on the mind than that which preceded it. The term is derived from the Greek word *klímax*, "a leader."

### 38. What is the most noted example of climax ?

Ans.—That of Cicero in his oration against Verres, "To *bind* a Roman citizen is an outrage; to *scourge* him is an atrocious crime; to *put him to death* is almost a parricide; but to *put him to death* BY CRUCIFIXION,—what shall I call it?"

Query.—What is the difference between climax in sound and climax in sense? What is a minor climax? Is it desirable to end sentences with the compounds *clear up*, *bring about*, *come over to*, *with it*, or *to it*? Should a sentence end with an adverb? What should determine the form of a sentence?

### 39. What is Harmony ?

Ans.—A term used to denote that smooth and easy flow

which pleases the ear. It consists in the use of euphonious, or pleasant-sounding words; the euphonious arrangement of words; and the adaptation of sound to the sense it expresses.

40. What words are to be avoided as unharmonious?

Ans.—1. Derivatives from long compound words; such as *barefacedness*. 2. Words containing a succession of consonant sounds; such as *strik'st*. 3. Those containing a succession of unaccented syllables; as, *mercinariness*. 4. Those in which a short or unaccented syllable is repeated, or followed by another that closely resembles it; as, *holily*.

NOTE.—Words which by themselves are sufficiently euphonious sometimes displease the ear on account of their proximity to certain other words in the sentence. Illustrated by *his history*; he *will* wilfully persist.

41. How is harmony promoted?

Ans.—1. By arranging the words in such a manner that the accents come at convenient and somewhat measured intervals. 2. By a due attention to the cadence at the close. 3. By the prevalence of pleasant sounds. 4. By adapting the sound to the sense.

42. What is meant by Figurative Language?

Ans.—A Figure, in Rhetoric, implies some departure from simplicity of expression or deviation from the plain and ordinary mode of speech, with a view of making the meaning more effective. There are three other classes: figures of orthography, figures of etymology, and figures of syntax.

NOTE.—Figures of orthography are intentional deviations from



the ordinary spelling of words. They are two in number: *Mime'-sis*, which consists in imitating the mispronunciation of a word, by means of false spelling; as, "I'll *argify*," and *Ar'-chaism*, or spelling a word according to ancient usage. The figures of etymology and syntax are treated of in Grammar.

#### 43. Name the figures and explain their origin.

Ans.—The most common figures are Simile, Metaphor, Allegory, Antithesis, Epigram, Metonymy, Synecdoche, Interrogation, Exclamation, Apostrophe, Personification, Hyperbole, and Irony. Their first source is the barrenness of language, and the second, and principal one, is the pleasure which they give.

NOTE.—Figures of words in distinction from figures of thought are called *tropes*. The ancients carefully observed this distinction, but at present the one term, *figure*, is used to cover the whole subject.

#### 44. Define Simile.

Ans.—The comparison of one object to another, and is generally denoted by *like*, *as*, or *so*; as, "Thy smile is *as* the dawn of the vernal day." The object of Simile is to increase the effect intended in the main assertion, whether that intention be to exalt or to degrade, to dignify or to burlesque.

NOTE.—Similes which have become trite and commonplace should not be used. Neither should those drawn from objects in which the likeness is too faint and remote (*far-fetched*), or those drawn from objects with which ordinary readers are unacquainted, be introduced into speech or writing.

#### 45. Define Metaphor.

Ans.—It is a figure founded upon the resemblance which one object bears to another. Hence, it is nearly

allied to Simile, of which it is really a sort of abridgment.  
Ex. "Wild fancies gambolled unbridled through his brain."

46. What is an Allegory?

Ans.—A narrative of fictitious events, whereby it is sought to convey or illustrate important truths; or it is a combination of kindred metaphors. Shorter allegorical combinations are more frequently called Fables, or Parables.

47. What rule is used in Allegory?

Ans.—The principal, almost the only rule, in regard to Allegory, is to avoid mingling the literal signification with the figurative.

48. Antithesis is what?

Ans.—It consists in putting two unlike things in juxtaposition, so that each will appear more striking by the contrast: as, Flattery brings friends; truth brings foes.

49. What is the meaning of Epigram?

Ans.—Originally, it meant an inscription on a monument. As such inscriptions are usually short, containing as much as possible in a few words, Epigram came next to mean any brief saying, prose or poetical, remarkable for brevity and point, and the word is even yet used largely in this sense. Ex. Language is the art of concealing thought.

NOTE.—Epigram in one sense consists mainly in a play upon words, and so leads to that last species of wit that the French call *jeu de mots*, and what we recognize in English as the *pun*, or play

upon words. To examples of paranomasia, may be added conundrums, rebuses, and riddles.

"And the Doctor told the Sexton,  
And the Sexton *told* the bell."—HOOD.

EPIGRAM ON A SHREW.

"They tell me that your brow is fair,  
And is surpassed by none;  
To me the cause is very clear—  
You *brow-beat* every one."

50. What means a change of name?

Ans.—Metonymy. This is a figure in which the name of one object is put for some other object, the two being so related that the mention of one naturally suggests the other; as, "The drunkard loves his *bottle*," and when, for instance, gray hairs are put for old age, as "to bring one's gray hairs with sorrow to the grave."

51. Define Synecdoche.

Ans.—It is using the name of a part for that of the whole, the name of the whole for that of a part, or a definite number for an indefinite, as, "The sea is covered with *sails*," i. e., *ships*; "She has seen sixteen sweet *summers* (*years*); "Ten thousand were on his right hand," i. e., *a great number*.

52. Explain the term Interrogation.

Ans.—We often ask a question, not for the purpose of getting an answer, or of receiving information, but as a means of expressing ourselves more strongly. It is as much as to say, there is but one possible answer to this question. By Interrogation, then, is meant the asking of questions, not for the purpose of expressing doubt or

obtaining information, but in order to assert strongly the reverse of what is asked. Example: "Doth God pervert judgment?" This is equivalent to saying, with strong emphasis, "God doth *not* pervert judgment."

### 53. What figure is similar to Interrogation?

ANS.—Exclamation. Instead of stating a fact simply and calmly, the writer or speaker utters an expression of surprise, or of emotion of some kind, on seeing that the thing is so.

NOTE.—Exclamations belong only to the stronger emotions of the mind; to surprise, admiration, anger, joy, grief, and the like. Both interrogation and exclamation, and, indeed, all passionate figures of speech, operate upon us by means of sympathy. Lyric and Dramatic poetry abounds with examples, and Hymns, being mainly expressive of emotion, afford more than any other species of composition.

Query.—Which book of the Bible contains constant employment of the rhetorical figure, Interrogation? What is Amplification? What was Curran's Pun? State advantages resulting from the use of figurative language. Give original illustrations of Simile, Metaphor, and Metonymy.

### 54. What is Apostrophe?

ANS.—It is an address to a real person, but one who is either absent or dead, as if he were present, and listening to us. It also addresses the inanimate as though animate, and occasionally indicates a high degree of excitement. Byron's "Apostrophe to the Ocean" is the most notable instance.

### 55. Define Personification.

ANS.—It is the attributing of sex, life, or action, to an inanimate object; or the ascribing of intelligence and per

sonality to an inferior creature; as, The mountains *sing* together. The moon shines in *her* radiant splendor. The sea *saw* it and fled.

### 56. What are the three degrees?

ANS.—The lowest form is that produced by adjectives; e. g., the *thirsty* ground; 2, That produced by verbs; as, The trees of the fields shall *clap* their hands. 3, That in which personification is combined with apostrophe. In such a case, an inanimate object is personified, and is at the same time addressed.

### 57. What is Hyperbole?

ANS.—Exaggerration. It consists in representing things to be either greater or less, better or worse, than they really are.

NOTE.—Hyperbolical expressions are of frequent occurrence in common conversation; we often say as *cold as ice*, as *white as snow*, *waves mountain high*, etc., in all which phrases the quality is exaggerated beyond the bounds of truth. Their frequency is to be attributed to the imagination, which always takes pleasure in magnifying the objects before it.

### 58. Irony is a form of what?

ANS.—Ridicule. The language in its literal acceptation is exactly the opposite of what the author means. The true meaning is indicated mainly by the tone of the voice, the words being spoken with a sneer, and hence it is sometimes called a figure of Elocution. Examples:

“Oh! as the bee upon the flower, I hang  
Upon the honey of thy eloquent tongue.”

Elijah to the priests of Baal, “Cry aloud, for he is a god.”

NOTE.—Other figures are used in Rhetoric, such as: (1) Vision



or Imagery, representing past events, or imaginary objects and scenes as actually present to the senses. Thus Cicero, in his fourth oration against Catiline: "I see before me the slaughtered heaps of citizens," etc. (2) Apophasis, Paralipsis, or Omission, is the pretended suppression of what one is all the time actually mentioning. (3) Onomatopœa is the use of a word or phrase formed to imitate the sound of the thing signified, as *bow wow* to express the barking of a dog; or *buzz, buzz* to indicate the noise made by bees.

Drills: Analyze the figure or figures in each passage:—"Ignorance is a blank sheet, on which we may write; but error is a scribbled one, from which we must first erase." "Are thy years as man's days?" "Drowsy night." "He smokes his pipe." "And Brutus is an *honorable* man."

"True ease in writing comes from art, not chance.

As those move easiest who have learned to dance."

"I am dying—Egypt—dying;

Hark! the insulting foeman's cry.

They are coming! Quick, my falchion!

Let me front them ere I die.

Oh! no more amid the battle

Will my heart exulting swell,

Isis and Osiris guard thee.

CLEOPATRA—ROME—farewell!"

## 59. Name the Special Properties of Style.

Ans.—Sublimity, Beauty, Wit, and Humor. The term Sublimity, for which Grandeur is by some used as an equivalent, is applied to great and noble objects which produce a sort of internal elevation and expansion. The principal source of the sublime is might, or power in a state of active exertion.

## 60. What are the various sources of Sublimity?

Ans.—The simplest form in which sublimity develops itself is *vastness*. The second circumstance that may be

named as producing a feeling of the sublime is *great power*. A third source is *a certain degree of awfulness and solemnity*. A fourth is *obscurity*. Another is *great loudness of sound*. And last, but not least, is that feeling awakened by the contemplation of anything strikingly great or noble in human actions; usually called the morally sublime.

61. What are examples of moral sublimity?

Ans.—1. Generous self-sacrifice, as instanced in the case of Damon and Pythias; Coriolanus and his mother; Codrus, the last Athenian king. 2. Self-possession and fearlessness, as illustrated in the case of Caesar crossing the stormy sea. 3. Exalted patriotism, as exhibited in the dying moments of Wolfe, Montcalm, and Warren.

62. Relate incidents illustrating these characteristics.

Ans.—An example of heroism is shown by Mucius Scævola, thrusting his arm into Porsenna's camp-fire, to show how he scorned his threatened tortures, and keeping it there with unmoved countenance till it was entirely consumed. Porsenna was so struck with the act that he gave the youth, who had come to murder him, his life, and subsequently negotiated a peace with Rome. An English transport, carrying passengers and troops, sprang a leak upon the Indian Ocean. Held to their duty by a young ensign, the four hundred troops gave up the life-boats to the passengers; and, forming in rank and file on the deck as the loaded boats sailed off to a safe distance, the passengers caught the sound of the young Ensign's voice, as he shouted, standing face to face with death: "Fire, my boys, a parting salute to Old England!" There came a volley of musketry, and when the smoke had cleared

away, not even a floating spar told where the vessel and her gallant freight had gone down beneath the waters.

NOTE.—Darkness, solitude and silence, which have a tendency to fill the mind with awe, contribute much to sublimity. Night scenes are generally the most sublime. The supernatural, including ghosts and goblins, enters into its composition. It is only a particular kind of loud sound that produces the feeling of sublimity. It is the roar of the storm, the cataract, or the bursting of a cannon, and not the shriek of the locomotive.

63. What are the essentials of sublimity in a literary composition?

ANS.—First, it is necessary that the subject be sublime; that the description be of natural objects capable of producing the emotion of grandeur; or, in other words, of what is vast, mighty, magnificent, obscure, dark, solemn, loud, pathetic, or terrible. To give effect to the description, a clear, strong, concise and simple style must be employed. The greatest thoughts must be presented in the fewest words. Simplicity is no less essential, and the writer's own enthusiasm must be awakened, or he cannot hope to excite emotion in others. Blank verse, owing to its freedom and variety, is the best medium for the expression of sublime ideas.

64. To what faults are writers of the sublime liable?

ANS.—Frigidity and Bombast. The first consists in degrading an object or sentiment which is sublime in itself, by our mean conception of it, or by a weak, low, and childish description. The second consists in attempting to raise an ordinary or trivial object above its level, and to endow it with a sublimity it does not possess.

Such attempts illustrate the old saying that "there is but a step from the sublime to the ridiculous."

65. What are the leading elements of beauty?

ANS.—Color, Figure, Smoothness, Motion, Complexity, Smallness and Delicacy, and Design. The requisites to beauty in composition are (1) that the subject of discourse be of an agreeable character, and (2) that the subject be handled in an agreeable manner. Conciseness is not as necessary an attribute, as it is to sublimity.

*Query.*—What is meant by moral beauty? Define gracefulness. What is music? What is meant by the "beautiful in writing?" Which is the best representation of complex beauty? What are the two divisions of Figure?

66. Give the definition of Wit.

ANS.—It is that quality of thoughts and expressions which excites in the mind an agreeable surprise, not by means of anything marvellous in the subject, but merely by employing a peculiar imagery, or presenting in a novel and singular relation ideas remotely connected.

67. How is this agreeable surprise produced?

ANS.—1. By degrading elevated things. 2. By aggrandizing insignificant things. 3. By representing objects in an unusual light by means of singular imagery. 4. By paronomasia.

68. What is said of the habit of punning?

ANS.—The habit of punning should be avoided, both in writing and in conversation. Facility in making puns is soon acquired, and when acquired, almost always leads

to such an excess as to weary both readers and hearers. There are, of course, exceptions to the rule. But, in general, there are few greater bores than an inveterate punster.

### 69. Of what does Humor consist?

Ans.—For the most part, in a representation of imaginary, short-lived, or over-strained emotions, which display themselves preposterously, or so as to excite derision rather than sympathy. Humor is not, like wit, sudden and short-lived; a brilliant scintillation, which flashes forth, and is then lost in obscurity. It often extends through entire productions; and, indeed, forms the staple of comic writing in general.

### 70. What is the aim of Humor?

Ans.—Simply to create a laugh. When there is an ulterior object—that is, when it is sought by means of this laugh to influence the opinions and purposes of the hearer or reader,—then humor becomes RIDICULE. In this case, a keener contempt of the weakness under review must be awakened than in the case of humor.

### 71. What is Versification? Give classification.

Ans.—Versification is the art of making verses. A *verse* is a metrical line of a length and rhythm determined by rules which usage has sanctioned. A *hemistich* is half a verse. A *distich*, or couplet, consists of two verses rhyming together. A *triplet* consists of three lines rhyming together. A *stanza* is a regular division of a poem, consisting of two or more lines, or verses.



*Query.*—What is a *quatrain*? What is the definition of *foot*? What is meant by “the length of a line?” What are the names of lines of one foot, two, three, four, five, and six feet respectively? Upon what does the kind of foot depend? To what is a long syllable equivalent? How is the quantity indicated?

## 72. Name the disyllabic feet.

ANS.—They are four in number, and illustrated as follows: Iambus, — —, (ǎwāke). Trochee, — —, (mĕrcý). Spondee, — —, (dǎrk night). Pyrrhic, — —, (hap- | pílý).

## 73. How many trisyllabic feet?

ANS.—Eight. Anapest, — — —, (řěřĕře). Dactyl, — — —, (mĕrcĭfŭl). Amphibrach, — — —, (řĕdŭndǎnt). Amphimacer, — — —, (wĭndĭng-shĕet). Bacchius, — — —, (thĕ dǎrk night). Antibacchius, — — —, ((ĕye-sĕrvǎnt). Molossus, — — —, (lōng dǎrk night). Tribrach, — — —, (insu- | pĕřǎblĕ).

NOTE.—Formerly a Heptameter, or a line of seven feet was much in use. What in Hymnology is called Common Metre was once Heptameter. We have in English the four kinds of verse, growing out of the kind of foot exclusively employed in each, namely, Iambic, Trochaic, Anapestic and Dactylic.

## 74. What is the difference between Rhyme and Rhythm?

ANS.—Rhyme is a similarity of sound in syllables which begin differently but end alike. Rhythm is the harmonious arrangement of syllables in reference to sound. Rhymes are divided into two classes, perfect and admissible. Example:

“Be thou the first true merit to befriend;  
His praise is lost who stays till all commend.”  
“Good nature and good sense must ever join:  
To err is human; to forgive divine.”

## 75. When is a line said to be *catalectic*?

Ans.—When a syllable is wanting at the end to complete the measure. One in which there is at the end a syllable over is called *hypercatalectic*. When there is neither deficiency or redundancy, a line is said to be *acatalectic*.

## 76. Define Blank Verse.

Ans.—It is verse that does not rhyme. Heroic lines, —that is, iambic pentameter,—when constructed without rhyme, constitute Blank Verse. This is the most elevated of all measures, and is the only form in which epic poetry should appear.

## 67. What is the law of English Verse?

Ans.—The prevailing law of English Verse is that the feet in any one line shall all be of one kind; that is, they shall all be iambuses, trochees, anapests, or dactyls, and the line be accordingly iambic, trochaic, anapestic, or dactylic.

## 78. What is the difference between Ancient and Modern Verse?

Ans.—Modern verse is governed by the accent; ancient verse was governed by the syllables, which had certain fixed and determinate lengths. Modern verse, therefore, is accentual; ancient verse was syllabic. Scan:

“There was a gay maiden lived down by the mill,  
Ferry me over the ferry—  
Her hair was as bright as the waves of a rill,  
When the sun on the brink of his setting stands still,  
Her lips were as full as a cherry.”—BOKER.

“The Assyrian came down like a wolf on the fold,  
And his cohorts were gleaming in purple and gold;  
And the sheen of their spears was like stars on the sea,  
When the blue wave rolls nightly on deep Galilee.”—BYRON

## 79. Define Poetry.

Ans.—It is the product of an excited and a creative imagination, with a primary object to please, and expressed in the form of verse. Most of the definitions of Poetry which have been proposed are open to the objection that they apply equally well to certain kinds of prose. They describe what is poetical, rather than what is poetry. A poetical composition bears these three marks: 1. It is the product of an excited imagination. 2. It is the product of a creative imagination. 3. Its primary object is to please.

### 80. Name the different kinds of poetry.

Ans.—*Epic*, which treats of the exploits of heroes. Ex. Homer's "Iliad," Virgil's "Æneid," and Milton's "Paradise Lost." *Dramatic*, which ranks with the Epic in dignity and excellence, and has nearly all its essential characteristics. The two kinds of drama are Tragedy and Comedy. Ex. The works of Euripides, Sophocles, and Shakespeare. *Lyric* is that variety which is adapted to singing and an accompaniment of the lyre or other musical instrument. Of lyric compositions, the Ode is the most elevated. Ex. The Odes of Pindar; "Alexander's Feast," by Dryden; Collins's "Ode on the Passions." *Elegiac*, which is usually of a sad and mournful kind, celebrating the virtues of some one deceased. *Pastoral* depicts shepherd life by means of narratives, songs, and dialogues. An Idyl is a short descriptive pastoral poem. An Eclogue is a pastoral in which shepherds are represented as conversing. The art of the pastoral poet lies in selecting for his descriptions the beauties of rural life, and carefully avoiding all its repulsive features. *Didactic*, which aims chiefly to give instruction. Generally devoted to the exposition of some dry abstract subject, it fails to interest the reader unless replete with ornament. Poetry

of this sort in English is very abundant, the best specimens being Young's "Night Thoughts," Pope's "Essay on Man," and Bryant's "Thanatopsis."

## 81. What is Prose?

ANS.—It is the term applied to all composition which is not in verse. It means the ordinary, straightforward manner of discourse, in distinction from the inverted forms so common in poetry.

NOTE.—The chief varieties of Prose composition are Letters, Diaries, News, Editorials, Reviews, Essays, Treatises, Travels, History, Fiction, and Discourses.

## 82. What is a Letter?

ANS.—A written communication on any subject from one person to another. The principal kind of letters are News Letters, Business Letters, Official Letters, Letters of Friendship, Letters of Condolence, of Congratulation, and of Introduction. Example of proper form of date and address:—

MUNCIE, Indiana, Oct. 11, 1881.

C. E. Johnson, Esq.,

MY DEAR SIR:

NOTE.—The points in a form of a letter requiring attention are the Heading, the Address, the Subscription, and the Superscription. It is remarkable how little attention is paid in epistolary correspondence (generally by those who *ought* to know better), to the ordinary form of punctuation, capitalization, and arrangement. In addressing a firm do not write *Gents*. It is a vulgarism, and is an abbreviation only of Gentiles, and not of gentlemen. D'r is an improper contraction of dear.

Query.—On what part of the envelope should the postage-stamp be placed? Of what does the superscription consist? Define Farce, Opera, Melodrama, and Burletta. In what measure is Poe's "Raven?" What is Scanning? What is Verse? Give a

definition of Prologue and Epilogue. What are Satires and Lam-poons?

83. In what respect do *essays* differ from *re-views*?

Ans.—A review, like an editorial, expresses the opinions of some acknowledged representative organ, and its utterances have, besides their own inherent value, whatever weight of authority has been acquired by that organ. But an essay stands solely on its own merits. It is in form entirely impersonal, or if the author introduces himself at all, it is in the singular "I," not with the editorial "we."

84. What is a Narrative?

Ans.—A composition which consists, for the most part, of an account of real facts or events; but into which description, argument, exposition, or speculation, may also be introduced.

85. Name its divisions.

Ans.—Narratives are divided into Histories, Biographies, Obituaries, Voyages, Travels, and Anecdotes. A History is an account of facts or events pertaining to distinguished places or objects, to communities, nations or states. A detached portion of history, confined to any particular era or event, is known as a Historical Sketch.

86. What is a Biography?

Ans.—It is an account of the life of an individual. When the chief incidents only are touched upon, it is called a Biographical Sketch. The writer should avoid a tendency to minuteness of uninteresting detail, and exagger-



ated praise of the person whose life he is treating. The definition of Autobiography is indicated in the etymology of the word: *αὐτός* (one's own), *βίος* (life), *γράφω* (to write).

87. What are the principal kinds of discourses?

ANS.—Orations, Addresses, Sermons, Lectures, and Speeches. [Define each.]

88. Part II. of Rhetoric is Invention. What is it?

ANS.—It means finding out what to say. It is divided into two branches: 1. Storing the mind with knowledge; 2. Selecting from this general store-house the thoughts needed for any particular occasion.

NOTE.—The first of these belongs to education and general intellectual culture, rather than to Rhetoric. If one is to write on any given subject, he can, of course, know better what to say if he is a man of profound and varied knowledge.

89. What is Composition?

ANS.—It is the art of inventing ideas and expressing them by means of written language. *A composition* is a written production on any subject, and of any length or style.

90. What is Description.

ANS.—It consists in delineating the characteristics of any object by means of words. It forms an important part of almost every variety of composition, and allows the widest scope for ornament and beauty of language. The

style used in description should correspond with the character of the object treated. If the latter is grand, the language in which it is described should be elevated in proportion. If beauty is the leading characteristic of the one, it should distinguish the other also. Whatever the nature of the object described, the style, to be effective, should be adapted to it.

91. How should a description of natural scenery be made?

ANS.—From the following heads: I. Circumstances under which it was seen; whether at sunrise, at noon, at sunset, or by moonlight; II. Natural features of the scene; level or undulating, fertile or barren; vegetation, trees, mountains, streams, etc., within view. III. Improvements of art; whether well cultivated; buildings, and other productions of human industry. IV. Living creatures that animate the scene; human beings. V. Neighboring inhabitants; peculiarities. VI. Sounds: murmur of a stream; noise of a waterfall; rustling of leaves; lowing of cattle; barking of dogs; singing of birds; cries of children; noise of machinery, etc. VII. Prospect, and comparison with any other scene. VIII. Historical associations and emotions awakened by these or native contemplation.

Amplify the following into a species of narration, drawing the obvious comparison: (1) Macbeth started at every whisper of the wind, or shriek of the night-hawk, when he went to murder Duncan; but stood as an "eagle against a sparrow, or a lion against a hare" in the fierce contest with the Norwegian rebels.

92. What is an essential condition to success in describing?

ANS.—The practice of noting down on the spot the

things to be described. In personal narrative, we can trust in good measure to recollection. But it is different in description. Here, if we wish to succeed, and to give to others a picture which will be thoroughly true and fresh, and which will bring up to their minds a scene exactly as it presented itself to ours, we must stand before it, pencil in hand, and note down its features while the eye is actually on them. Trace, at length, the points of resemblance between the given subjects that follow: *Life*—an ocean. *Earth*—a mother. *Uncultivated genius*—an unpolished diamond. *Neglected talent*—a flower in the desert. *Youth*—morning. *Old age*—sunset.

NOTE.—A good exercise is to have pupils write a letter to a friend describing what they did in one day; to give an account of the "trip" to and from school; a description of any particular event that may have happened to them or others, or of a visit to city or country. Our class-books offer a variety of subjects for the consideration of advanced pupils.

### 93. What is a Parallel?

Ans.—A comparison showing the points of similitude and difference between two persons, characters, or objects that resemble each other either in appearance or reality.

### 94. Define Paraphrase.

Ans.—It is the amplified explanation of a passage in clearer terms than those employed by the author. Ex. *Wealth begets want. Paraphrase.* The desires of man increase with his acquisitions. Every step that he advances brings something within his view, which he did not see before, and which, as soon as he sees it, he begins to want. When necessity ends, curiosity begins; etc., *ad libitum*.

### 95. What is Abridging?

Ans.—Epitomizing is the opposite of Amplification, and consists in expressing the substance of a passage, article, or volume, in fewer words.

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### Rehearsal.

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What kind of metre and stanza is the following?

“With a jaunty cloak and swagger, and a jeweled-handled dagger,  
And a lute across his shoulder, by a ribbon—blue at that!  
And his breeches, never bigger than would show his shapely figure,  
And a fascinating feather in his jaunty little hat.

What is meant by saying a thing is *incongruous*? Give an example of the Spenserian stanza. What is a Sonnet? What is a paramount law in all speech? Name three points of excellence in style, and tell what you mean by each. What evils would result from directly imitating the style of another? What illustration can you give of the adage, “*de gustibus non disputandum*”? What is the standard in taste? Explain the difference between taste and genius. Have you read Campbell’s “Essay on Use as the Law of Language”? What is meant by an ideographic system of writing? The following is an illustration of what?—“He lost his wife, his child, his household goods, and his *dog*, at one fell swoop. What are Burlesques? Give an example of a “far-fetched” simile. Define a mixed metaphor. Bunyan’s “Pilgrim’s Progress” is an example of what rhetorical figure? What does *tropes* mean? Give the etymology of *epic*. What is meant by repetition? What are the dangers of wit? What are its advantages? Combine the following groups of statements into one simple or complex sentence:—In the Olympic games, the only reward was a wreath of wild olive. The Olympic games were regarded as the most honorable contests. They were so

regarded because they were sacred to Jupiter. How did the Alexandrine obtain its name? What is meant by *pure* measure? What are the three common stanzas? Define the Hallelujah metre. What is a Note? Define Diary, Essay, and Review. Who has been called the "Prince of Reviewers"? Would you write, Yours Very Truly, or, Yours very truly? Why? What are the names given to works of fiction? How do you change expressions from the common to the rhetorical style? What is good English? When should the formal study of rhetoric be introduced into schools? What is a Peroration? Write a congratulatory letter. Write a composition upon "Gossip," of not more than fifty lines. Can you write a *travestie* on Longfellow's "Psalm of Life"? What is meant by a scale of criticism? What is a Madrigal? How can energy be secured? What do you include under the term Invention?







# BOTANY.



# BOTANY.

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## 1. What is Botany?

Ans.—It is the science of the vegetable kingdom, and includes a systematic knowledge of the forms, organs, intimate structures, growth, history, classification and uses of plants.

NOTE.—Physiology is the study of the way a living being lives, and grows, and performs its various operations. The study of plants in this view is the province of *Vegetable Physiology*. The study of the form and structure of the organs or parts of the vegetable, by which its operations are performed, is the province of *Structural Botany*. The two constitute *Physiological Botany*.

## 2. Define Plant.

Ans.—“It is a cellular body, possessing vitality, living by absorption through its outer surface, and secreting starch.”

NOTE.—There is hardly an exception to the fact, that the plantlet exists ready-formed in the seed in some shape or other. The rudimentary plantlet contained in the seed is called an *Embryo*.

## 3. What is the Radicle?

Ans.—It is the root end of the embryo. It was so named because it was supposed to be the root, when the difference between the root and stem was not so well

known as now. A better name would be *Caulicle*, i. e., "little stem."

#### 4. What are the *axes*?

ANS.—One part, the root, grows downward into the soil: it may, therefore, be called the *descending axis*. The other grows upward into the light and air: it may be called the *ascending axis*.

NOTE.—The root grows on continually from the extremity, and so does not consist of joints, nor does it bear leaves or anything of the kind. The stem grows by a succession of joints, each bearing one or more leaves on its summit.

#### 5. What are Cotylédons?

ANS.—The seed-lobes. After they are relieved from the nourishment with which their tissue is gorged, they expand into useful green leaves. The little bud of undeveloped leaves which is to be found between the cotyledons before germination, in many cases (as in the Pea, Bean, etc.,) has been named the *Plumule*.

#### 6. Describe the cotyledons of the Pea.

ANS.—They make up nearly the whole bulk of the seed, and are so excessively thickened as to become nearly hemispherical in shape. They have lost all likeness to leaves, and all power of ever-fulfilling the office of leaves. Accordingly in germination they remain unchanged within the husk or coats of the seed, never growing themselves, but supplying abundant nourishment to the plumule. This pushes forward from the seed, shoots upward, and gives rise to the first leaves that appear. In most cases of this sort, the radicle lengthens very little, or not at all; and so the cotyledons remain under ground.



## 7. How is the food deposited?

Ans.—The nourishment provided for the seedling plantlet is usually laid up *in* the embryo, but very often it is *around* it. A notable instance is furnished by the common Morning Glory or *Convólulus purpureus*. The embryo consists of a short stemlet and a pair of very thin and delicate green leaves, having no stock of nourishment in them for sustaining the earliest growth. Cutting open the seed we see that the embryo (considerably crumpled or folded together, so as to occupy less space) is surrounded by a mass of rich, mucilaginous matter (becoming rather hard and solid when dry), which forms the principal bulk of the seed. Upon this stock the embryo feeds in germination; the seed-leaves absorbing it into their tissue as it is rendered soluble and dissolved by the water which the germinating seed imbibes from the moist soil. Having by this aid lengthened its radicle into a stem of considerable length, and formed the beginning of a root at its lower end, already imbedded in the soil, the cotyledons now disengage themselves from the seed coats, and expand in the light as the first pair of leaves.

## 8. What is said of the Root?

Ans.—It has no such aspiration. Growing downward from the first moment of its breaking through the seed-coats, it persistently avoids the air and light, seeking the dark, damp depths of the soil. Its innumerable fibres are many months absorbing water and earthy matters, which ascend and mix with the air and gases absorbed by the leaves. Chemical action is induced by the rays of the sun, transforming all into nourishing sap for the life and growth of every part of the plant.

## 9. What is Albumen?

Ans.—This material store of food, deposited in the seed along with the embryo (but not in its substance), the old botanists likened to the *albumen*, or white of the egg, which encloses the yolk, and therefore gave it the same name—the *albumen* of the seed—a name which it still retains. Food of this sort for the plant is also food for animals, or for man; and it is this albumen, the floury part of the seed, which forms the principal bulk of the leading grains.

NOTE.—The question of a seed's vitality is interesting at least to the gardener. He accepts all kinds as good for a year, and, as a rule, rejects such as are known to be older. There are, however, many kinds of seeds which are long-lived. The seeds of Maize and Rye have been known to grow after 30 or 40 years old; Kidney Beans when 100, and the Raspberry (according to Lindley) after 1700 years. It is often observed that when from deep excavations earths are first brought to the surface, they are soon covered with strange plants, probably from seeds long buried. After the "Great Fire in London," the Hedge Mustard (*Sisymbrium*) previously unknown in that locality, sprang up thickly amid the blackened ruins.

Query.—What is the meaning of *dicotyledonous*? Define *root*, and tell its office to the plant. Wherein does *stem* differ from root? Describe the "plan of vegetation." Embryos with many cotyledons are said to be what?

## 10. Describe Buds.

Ans.—These regularly appear in the *axils* of the leaves, that is, in the angle formed by the leaf with the stem on the upper side; and as the leaves are symmetrically arranged on the stem, the buds, and the branches into which the buds grow, necessarily partake of this symmetry.

NOTE.—We do not confine the name of bud to the scaly winter buds which are so conspicuous on most of our shrubs and trees in

winter and spring. It belongs as well to the forming branch of any herb, at its first appearance in the axil of a leaf.

### 11. Distinguish between terminal and axillary buds.

Ans.—There are herbs, shrubs, and trees which do not branch, but whose stems, even when they live for many years, rise as a simple shaft. These plants grow by the continued evolution of a bud which crowns the summit of the stem, and which is therefore called the *terminal bud*. *Axillary buds* are formed in the trees early in the summer. Occasionally, they grow at the time into branches: at least, some of them are pretty sure to do so, in case the growing terminal bud at the end of the shoot is injured or destroyed: Otherwise they lie dormant until the spring.

### 12. What is the arrangement of leaves?

Ans.—They are arranged in two principal ways, *opposite* or *alternate*. They are *opposite* when there are two borne on the same joint of the stem, the two leaves in such cases being always *opposite* each other, that is, on exactly opposite sides of the stem. They are *alternate* when there is only one from each joint of stem—not counting the seed-leaves, which are, of course, opposite, there being a pair of them.

### 13. What are the various forms of stems?

Ans.—1. *Herbaceous*, when it dies down to the ground every year, or after blossoming. 2 *Suffrutescent*, when the bottom of the stem above the soil is a little woody, and inclined to live from year to year. 3. *Suffruticose*, when low stems are decidedly woody below, but herbaceous above. 4. *Fruticose*, or *shrubby*, when woody, living from

year to year, and of considerable size,—not, however, more than three or four times the height of a man. 5. *Arborescent*, when tree-like in appearance, or approaching a tree in size. 6. *Arboreous*, when forming a proper tree trunk.

#### 14. What are *consolidated plants*?

ANS.—Those which are formed on the plan of the least possible amount of surface in proportion to their bulk. The Giant *Cereus* of the Gila River is a noted example. They are evidently adapted and designed for very dry seasons, and during a long hot season in which little or no rain falls, their stalks and foliage above and their roots beneath being early cut off by drought, the plants rest securely in their compact bulbs filled with nourishment, and retain their moisture with great tenacity, until the rainy season comes round.

#### 15. What is a Bulb?

ANS.—An extremely short subterranean stem, usually much broader than high, producing roots from underneath, and covered with leaves or the bases of leaves, in the form of thickened scales. *Bulblets* are small bulbs formed above ground on some plants, as in the axils of the leaves of the common Lily of the gardens. They are plainly nothing but bulbs with thickened scales. They never grow into branches, but detach themselves when full grown, and fall to the ground, to take root there and form new plants.

Query.—What purpose do bulbs serve? When is a bulb said to be *tunicated*? Define the terms *diffuse*, *decumbent*, *declined*, *assurgent*, *procumbent*, *scandent*, etc., when applied to the direction taken by stems. What are *suckers*, *offsets*, *stolons*, and *runners*? What is a *rhizoma*? Give examples of *tubers*.

### 16. What is Vernation?

Ans.—The arrangement of the leaves in the bud. In the Osmund Ferns, when starting from the ground in early spring, each *frond* (combination of stalk and leaf) is a coil rolled from the top inward and downward, gradually unfolding, scroll-like, as it grows. This mode of bud-folding is termed *circinate*.

### 17. Name the parts of the Leaf?

Ans.—The principal part of a leaf is the *blade*, or extended portion, one face of which naturally looks toward the sky, the other toward the earth. The blade is often raised on a stalk of its own, and on each side of the stalk at its *base*, there is sometimes an appendage called a *stipule*. A complete leaf, therefore, consists of a *blade*, a *foot-stalk* or *leaf-stalk*, called the *petiole*, and a pair of *stipules*.

### 18. Describe the Leaf.

Ans.—It consists of (1) the *green pulp* or *parenchyma*, and (2) the *fibrous framework*, or skeleton, which extends throughout the soft green pulp and supports it, giving the leaf a strength and firmness which it would not otherwise possess. Besides, the whole surface is covered with a transparent skin, called the *epidermis*, like that which covers the surface of the shoots.

### 19. Of what does the framework consist?

Ans.—*Wood*; a fibrous and tough material which runs from the stem through the leaf-stalk (when there is one) in the form of parallel threads or bundles of fibres; and in the blade these spread out in a horizontal direction, to form the *ribs* and *veins* of the leaf. The stout main



branches of the framework are called the *ribs*. When there is only one, or a middle one decidedly larger than the rest, it is called the *midrib*. The smaller divisions are termed *veins*; and their still smaller sub-divisions, *veinlets*.

## 20. Define Venation.

Ans.—It is the arrangement of the veins, and is of two principal kinds, namely, the *parallel-veined* and the *netted-veined*. In parallel-veined leaves, the whole framework consists of slender ribs or veins, which run parallel with each other, or nearly so, from the base to the point of the leaf, not dividing and subdividing, nor forming meshes, except by very minute cross veinlets. In netted-veined (*reticulated*) leaves, the veins branch off from the main rib or ribs, divide into finer and finer veinlets, and the branches unite with each other to form meshes of network. That is, they *anastomose*, as do the veins and arteries of the body.

NOTE.—The *veinulets* branch from the veins, then divide or fork, and so end either in the edge (margin) of the *frond*, or in a fruit-cluster. This kind of veining in the larger veins is styled *pinnate-veined*, *pinnately-veined*, or *feather-veined*, and that in the veinulets, *fork-veined*. To the last is added the terms, *palmately*, *digitately* or *radiately-veined*.

## 21. What is said of the General Outline of leaves?

Ans.—It is necessary to give names to the principal shapes, and to define them rather precisely, since they afford the easiest marks for distinguishing species. Beginning with the narrower and proceeding to the broadest forms, a leaf is said to be *Linear*, *Lanceolate*, or *lance shaped*, *Oblong*, *Elliptical*, *Oval*, *Ovate*, *Orbicular*, or *rotund*, *Oblanceolate*, *Spatulate*, *Obovate*, *Cuneate*, *Cuneiform* or *wedge shaped*.

22. What forms are characterized by the Base of the leaf?

ANS.—*Cordate* or *heart-shaped*, *Reniform* or *kidney-shaped*, *Auriculate* or *ear-shaped*, *Sagittate* or *arrow-shaped*, *Hastate* or *halberd shaped*, and *Peltate* or *shield-shaped*.

NOTE.—The following terms express the principal variations of the the apex of the leaf: *Acuminate*, *pointed* or *taper-pointed*, *Acute*, *Obtuse*, *Truncate*, *Retuse*, *Emarginate*, or *notched*, *Obcordate*, *Cuspidate*, *Mucronate*, *Aristate*, *awn-pointed*, or *bristle-pointed*.

23. Name the "particular outlines" of leaves.

ANS.—*Entire*, *Serrate* or *saw-toothed*, *Dentate* or *toothed*, *Crenate* or *scolloped*, *Repand*, *undulate* or *wavy*, *Sinuuate*, *Incised*, *cut* or *jagged*. When leaves are more deeply cut, and with a definite number of incisions they are said to be *lobed*; the parts being called *lobes*.

NOTE.—When the depth and character of the lobing needs to be more particularly specified, the following terms are used: *Lobed*, *Cleft*, *Parted*, *Divided*, etc.

Query.—When is a leaf said to be *quadrifid*? When *trisected*? What is meant by the *mode* of division? Analyze an oak-leaf. What are *pinnate* leaves? Define *phyllodia*.

24. What is the third arrangement of leaves?

ANS.—*Whorled* or *verticillate*, when there are three or more leaves in a circle (*whorl* or *verticil*) on one joint of stem. But this is only a variation of the *opposite* mode; or rather the latter arrangement is the same as the whorled, with the number of the leaves reduced to two on each whorl.

NOTE.—The shape of leaves depends on the venation. *Palm* or *palmate-veined* leaves, wherein there are several chief veins running from the base of the blade to the margin, will generally

be broad in outline—as broadly ovate, or orbicular, or reniform; and often palmately trilobate, 5-lobed, 7-lobed, according to the number of veins.

## 25. What are the organs of Reproduction?

ANS.—The *seed*, and the *fruit* in which the seed is formed, and the *flower*, from which the fruit results. *Inflorescence*, or the mode of flowering, is the situation and arrangement of blossoms on the plant.

## 26. What is the flower?

ANS.—The collection of organs which directly or indirectly contribute to the process of reproduction by seed. It may consist of essential and non-essential organs. Flowers are either *terminal* or *axillary*. The same plant usually produces both kinds of leaf-buds, but it rarely bears flowers in both situations. These are usually either all axillary or all terminal, giving rise to two classes of inflorescence, namely, the *determinate* and the *indeterminate*.

## 27. Define the two classes.

ANS.—The *Terminal Centrifugal* or *Definite* is that where the flowers are terminated in a single axis, the blossoming proceeding from the centre outward. The *Axillary Centripetal* or *Indefinite* is that where the flowers all arise from axillary buds, and while these buds give rise to flowers, the terminal bud goes on to grow, and continues the stem indefinitely.

NOTE.—Of axillary inflorescence we may have the following kinds:—1. *Spike*, a long axis or rachis, with clustered, scattered, or crowded sessile flowers as in Mullein, Plantain. 2. *Spikelets*, the branches of a compound spike, as in wheat and others of the

grass family. 3. *Catkin* or *Ament*, slender spikes, pendent with scaly ducts, as in Oak and Willow. 4. *Spadix*, flowers closely arranged on a thick, fleshy rachis, sometimes with a spathe enveloping it, as in Indian Turnip. 5. *Raceme*, the same as a spike, except that the flowers are on pedicels, as in the Currant. 6. *Umbel*, when several pedicels of nearly equal length proceed from a common centre, giving the appearance of an umbrella. The pedicels may themselves become umbels, producing a compound umbel; the primary pedicels are then called *rays*, and the secondary umbels, *umbellets*. 7. *Corymb*, a raceme with the lower pedicels lengthened, making all the flowers stand at nearly the same height. It may be simple or compound. 8. *Head*, a kind of compact umbel, the flowers all sessile on the end of the stem, as in the Clover and Compositæ. 9. *Panicle*, an irregular, loose flower cluster, as in Oats. 10. *Thryse*, a compact, pyramidal panicle, as in the Grape.

### 28. When is a flower said to be *sessile*?

Ans.—A flower (or other body) which has no stalk to support it, but which sits directly on the stem or axis from which it proceeds, is said to be *sessile*. If it has a stalk, this is called its *peduncle*. If the whole flower-cluster is raised on a stalk this is called the peduncle or the *common peduncle*: and the stalk of each particular flower, if it have any, is called the *pedicel* or *partial peduncle*.

### 29. What is the *rachis*?

Ans.—The position of the general stalk along which flowers are disposed is called the *axis of inflorescence*, or when covered with sessile flowers, the *rachis* (back-bone), and sometimes the *receptacle*. The leaves of a flower-cluster generally are termed *bracts*.

### 30. What are the divisions of determinate inflorescence?

Ans.—1. *Cyme*, a level-topped or convex flower-cluster,

resembling the corymb except that the flowers are centrifugal, as in the Elder. 2. *Fascicle*, like that of the Sweet William and *Lychnis* of the gardens, is only a cyme with the flowers much crowded, as it were, into a bundle. 3. *Glomerule*, a cyme still more compacted, so as to form a sort of head. It may be known from a true head by the flowers not expanding centripetally; *i. e.*, not from the circumference towards the center, or from the bottom to the top.

### 31. Name the organs of the flower.

ANS.—They are of two kinds: first, the *protecting organs*, or *leaves of the flower*—also called the *floral envelopes*,—and second, the essential organs.

### 32. Describe the Floral Envelopes.

ANS.—Those in a complete flower are double; that is, they consist of two *whorls*, or circles of leaves, one above or within the other. The outer whorl, generally green,\* sometimes colored, separated, or united into a ring or cup, is called the *calyx*. Its divisions are called *sepals*. The inner whorl, separate or united, usually colored, is called the *corolla*. Its divisions are *petals*.

NOTE.—If there is but *one whorl*, it is always the calyx; that is, there may be a calyx without a corolla, but there cannot be a corolla without a calyx. Both calyx and corolla may be wanting. The calyx and corolla together are sometimes called the *perianth*. They are not directly concerned in the production of the seed, but are only for protection of the other organs; hence they are called the *non-essential* organs.

### 33. What are the *essential* organs?

ANS.—They are of two kinds, placed one above or with-

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\* In Botany, the term *color* means any color (including white) except green.



In the other; first, the thread-like organs, varying in number from one to a hundred or more, situated just within the perianth are called the *stamens*. Taken together they are sometimes called the *andrecium*. The thread-like portion of the stamen is called the *filament*. It is non-essential, and sometimes wanting. The *anther* consists of a closed sac divided into cells, and containing a fine yellow dust called *pollen*. The use of the pollen is to fertilize the embryo seeds. When the filament, which is but the stalk of the anther, is wanting, the anther is said to be *sessile*. Second, the organs which occupy the center of the flower comprising the fourth whorl, are called *pistils*. Taken together they are called the *gynecium*. A complete pistil is composed of the *ovary*, *style* and *stigma*. The ovary is a closed case containing the embryo seeds, or *ovules*. The style is the thread-like portion which, when present, bears the stigma on its end. The stigma is the tip, or extremity, of the style, or of the ovary when the style is wanting. The use of the ovary is to bear the embryo seeds (ovules) where they are fertilized by the pollen from the anther falling on the stigma and penetrating the ovary through the style.

NOTE.—Taking them in succession, therefore, beginning from below, or at the outside, we have first, the *calyx* or outer circle of leaves, which are individually termed *sepals*; secondly, the *corolla* or inner circle of delicate leaves, called *petals*; then a set of *stamens*; and in the center one or more *pistils*. The end of the flower-stalk, or the short axis, upon which all these parts stand, is called the *Torus* or *Receptacle*.

### 34. What is a Typical Flower?

ANS.—A *pattern flower*, which exemplifies the plan upon which all flowers are made, and serves as what is called a *type*, or standard of comparison. The Flax and Stonecrop are good examples. The typical flower must be: 1.

*Perfect*, provided with both kinds of essential organs, viz., stamens and pistils. 2. *Complete*, having the four sets of organs arranged in concentric circles. 3. *Regular*, having parts of each set of the same shape and size. 4. *Symmetrical*, having an equal number of parts of each sort, or in each set or circle of organs. 5. *Alternating*, having the several parts of each set stand alternating in position to the parts of the next set. 6. *Distinct*, having all parts disconnected.

35. What are the variations from the *type*?

Ans.—I. *Incomplete*, deficient in respect to floral envelopes:

1. Corolla wanting, apetalous, or monochlamydeous.

2. Calyx and corolla wanting, naked, or achlamydeous.

II. *Imperfect*, deficient in respect to essential organs:

1. Pistils wanting, staminate, or sterile.

2. Stamens wanting, pistillate, or fertile.

3. Pistils and stamens both wanting, neutral.

III. Irregular.

IV. Unsymmetrical.

V. Organs opposite.

VI. Cohesion.

VII. Adhesion.

NOTE.—The terms “calyx superior,” “ovary inferior,” “ovary adherent,” “calyx adherent,” all mean the same as “calyx epigynous.” The terms “calyx inferior,” “calyx free,” “ovary free,” all mean the same as “calyx hypogynous.” These terms are used frequently in analysis.

Query.—What is the meaning of *perigynous*, *epigynous*, and *hypogynous*? What are the characteristic forms of the perianth? The following terms are used to denote the varying duration of

the perianth: define them. Deciduous, Caduceous, Persistent, Accrescent, Marescent. What are *spurs*, *crowns*, and *scales*? What is the meaning of "gamopetalous" and "urceolate?"

36. What is the "numerical plan" of the flower?

Ans.—Although not readily discerned in all cases, yet generally it is plain to see that each blossom is based upon a particular number, which runs through all or most of its parts. Some flowers of the Stonecrop have their parts in fours, and then that number runs throughout; namely, there are four sepals, four petals, eight stamens (two sets), and four pistils. *Five* is the most common number in flowers, and next to this is *three*.

37. What relation do flowers bear to branches?

Ans.—Flowers are altered branches, and their parts, therefore, altered leaves. That is, certain buds, which might have grown and lengthened into a leafy branch, do, under other circumstances and to accomplish other purposes, develop into blossoms. In these the axis remains short, nearly as it is in the bud; the leaves therefore remain close together in sets or circles; the outer ones, those of the calyx, generally partake more or less of the character of foliage; the next set are more delicate, and form the corolla, while the rest, the stamens and pistils, appear under forms very different from those of ordinary leaves, and are concerned in production of seed.

38. What is Cohesion?

Ans.—The calyx or corolla is frequently found to be a cup or tube, instead of a set of leaves. The best examples are the flowers of the Stramonium, Thorn-apple, and

Morning-glory, Where the parts are united, much or little, the corolla is said to be *monopetalous* and the calyx *monosepalous*. Where the stamens are united in one set they are said to be *monadelphous*; in two sets, *diadelphous*; in many sets, *polyadelphous*; by their anthers, *syngeneceous*. Where the pistils are united they form a *compound pistil*, the divisions being called *carpels*.

39. When is the flower said to be "*parted*?"

Ans.—When the parts of the corolla or calyx taken as a whole are separate almost to the base. They are said to be *cleft*, or *lobed*, when the notches do not extend below the middle or thereabouts; *toothed* or *dentate*, when only the tips are separate as short points; *entire*, when the border is even, without points or notches.

NOTE.—Other divisions will be found by referring to the characteristic forms of the perianth as generally given under five headings.

40. Give examples of the Papilionaceous flower.

Ans.—The Pea, Bean, Locust, and nearly all that family. In this we have an irregular corolla of a peculiar shape, which Linnæus (the founder of the science of Botany) likened to a butterfly—from the Latin *papilio*, "a butterfly." The five petals of a papilionaceous corolla have received different names taken from widely different objects. The upper and larger petal which is generally wrapped round all the rest in the bud, is called the *standard*, *banner*, or *vexillum*. The two side petals are called *wings*, or *alae*. The two side anterior ones, the blades of which commonly stick together a little, and which enclose the stamens and pistil in the flower, from their forming a

body shaped somewhat like the keel, or rather the prow, of an ancient boat, are together named the *keel* or *carinum*.

#### 41. Describe the Ligulate.

ANS.—It is the *strap-shaped* corolla of most *compound flowers*. What is called the compound flower of the Thistle, Sunflower, Aster, or Dandelion, consists of many distinct blossoms, closely crowded together into a head, and surrounded by an *involucre*. A common mistake is to regard the whole for one flower, the involucre for a calyx, and corollas of the outer or of all the flower as petals. And this is very natural when the flowers around the edge have flat and open or strap-shaped corollas, while the rest are regular and tubular, but small, as in the Sunflower. In the Coreopsis, the *ray-flower* consists merely of a strap-shaped corolla, raised on the small rudiment of an ovary; it is therefore a *neutral* flower, like those of the ray, or margin of the cluster in Hydrangea, only of a different shape. More commonly the flowers with a strap-shaped corolla are *pistillate*; that is, have a pistil only, and produce seed like the others, as in Whiteweed. But in the Dandelion, etc., these flowers are perfect, bearing both stamens and pistils. And, moreover, all the flowers of the head are strap-shaped and alike.

#### 42. What is *Æstivation* or *Præfloration*?

ANS.—*Æstivation* (from *æstivus*, in summer) shows how the envelopes are folded in the bud, or it relates to the way in which the leaves of the flower, or the lobes of the calyx or corolla, are placed with respect to each other in the bud.

#### 43. What are its various forms?



ANS.—The pieces of the calyx or the corolla either over-reach each other in the bud, or they do not. When they do not, the æstivation is commonly *Valvate*, *Induplicate*, *Reduplicate*, *convolute* or *twisted*, *Imbricated* (*joint breaking*). Define each.

NOTE.—When the calyx or the corolla is tubular, the shape of the tube in the bud has sometime to be considered, as well as the way the lobes are arranged. For example, it may be *Plated* or *Plicate*; i. e., folded lengthwise; and the plaits may either be turned outwards, forming projecting ridges, or turned inwards, as in the corolla of the Gentian. When the plaits are wrapped round all in one direction, so as to cover one another in a convolute manner, the æstivation is said to be *Supervolute*.

#### 44. When are stamens “Gynandrous”?

ANS.—When they are consolidated with the style, so as to be borne by it, as in the Lady’s Slipper and all the Cactus family. They are said to be *Epipetalous* when they are borne by the corolla.

#### 45. How is number in the flower sometimes expressed?

ANS.—By terms compounded of the Greek numerals and the word used to signify stamen; as *monandrous*, for a flower having only one stamen; *diandrous*, one with two stamens; *triandrous*, with three stamens; and so on, up to *polyandrous*, (meaning with many stamens) when there are twenty or a larger number, as in a Cactus.

NOTE.—Two terms are used to express particular numbers with unequal length. Namely, the stamens are *didynamous* when only four in number, two longer than the other two, as in the Mint and Catnip; and *tetradynamous* when there are six, with four of them regularly longer than the other two, as in the Mustard and all that family.

## 46. Describe Pollen.

Ans.—A grain of pollen is made up of two coats; the outer coat thickish, but weak, and frequently adorned with lilies or bands, or studded with points; the inner coat is extremely thin and delicate, but extensible, and its cavity is filled with a thickish fluid, often rendered turbid by an immense number of minute grains that float in it. When wet, the grains absorb the water and swell so much that many kinds soon burst and discharge their contents.

47. What is said of the *Gymnospermous* pistil?

Ans.—The meaning of the word is *naked-seeded*, and it is the most peculiar, and yet the simplest of all pistils. While the ordinary simple pistil represents a leaf rolled together into a closed pod, those of the Cedar, Larch, and Pine are plainly open leaves, in the form of scales, each bearing two or more ovules on the inner face, next the base. At the time of blossoming these pistil leaves of the young cone diverge, and the pollen, so abundantly shed from the staminate blossoms, falls directly upon the exposed ovules. Afterwards the scales close over each other until the seeds are ripe. Then they separate again, that the seeds may be shed. As their ovules and seeds are not enclosed in a pod, all such plants are said to be *Gymnospermous*.

## 48. What are the classes of ovules?

Ans.—1. Orthotropous, or straight; 2. Campylotropous or curved; 3. Anatropous, or inverted; and, 4. Amphitropous, or half-anatropous. As to their direction, they are Horizontal, Ascending, Erect, Pendulous, and Suspended.

*Query.*—What is the “*hilum*”? Locate the “*chalaza*.” What is an annual herb? a biennial? a perennial? Define a *shrub*. How does a tree differ from a shrub? What is vegetation? What are “aerial roots”? What are Epiphytes? What is meant by the “spiral arrangement” of leaves?

*NOTE.*—Some very interesting particular laws respecting “spiral arrangement” have been pointed out by Braun, a German naturalist. For example, in the elm and many others, the 3d leaf is placed immediately over the 1st, the 4th over the 2d, and so on. This makes a *cycle*, which is expressed by the fraction  $\frac{1}{2}$ , the numerator denoting the revolutions, the denominator the number of leaves in each, and the fraction the angular distance between the leaves, i. e.,  $\frac{1}{2}$  of  $360^\circ$ . In the birch and others the fraction is  $\frac{1}{3}$ ; in the cherry, apple, etc., it is  $\frac{2}{5}$ ; in Osage, orange, and others,  $\frac{3}{8}$ . These fractions form a series in which the terms of each are equal to the sum of the two preceding. The next then would be

$$\begin{array}{r} 2 + 3 = 5 \\ 5 + 8 = 13, \end{array}$$

which is the cycle of the cones of most of the pines. The next,  $\frac{8}{13}$ , is represented in the house leek and Scotch pine.

#### 49. What is a disk?

*Ans.*—It is a part of the receptacle, or a growth from it, enlarged under or around the pistil. It is hypogynous when free from all union either with the pistil or the calyx, as in the Rue and the Orange. It is perigynous when it adheres to the base of the calyx, as in the Bladder-nut and Buckthorn. In adhering both to the calyx and to the ovary, consolidating the whole together, it is sometimes carried up and expanded on the top of the ovary, as in the Parsley and Ginseng families, when it is said to be epigynous.

#### 50. What is fruit?

*Ans.*—It is the perfected ovary. It consists of the *pericarp* and the seed. The seeds are the perfected ovules

and are embryos of the future plant. The pericarp is the envelope of the seed, or the perfected walls of the ovary. The divisions are called *carpels*. The pericarp does not always completely enclose the seeds, plants of the pine kind and some others being exceptions.

### 51. Name the kinds of fruits.

ANS.—They are three in number, viz: 1, Fleshy Fruits; 2, Stone Fruits; and 3, Dry Fruits. In fleshy fruits, the whole pericarp thickens and becomes soft (fleshy, juicy or pulpy) as it ripens. Of this the leading kind is the *berry*, such as the gooseberry, currant, cranberry, blueberry, tomato, and grape. The orange is merely a berry with a leathery rind.

### 52. What other forms are there of the *berry*?

ANS.—THE PEPO, or Gourd-fruit, is the sort of berry which belongs to the Gourd family, mostly with a hard rind, and the inner portion softer. The pumpkin, squash, cucumber and melon are the leading representatives. THE POME is a name applied to the apple, pear, and quince; fleshy fruits, like a berry, but the principal thickness is calyx, only the papery pods arranged like a star in the core really belonging to the pistil itself.

### 53. Give examples of the Stone Fruit.

ANS.—The cherry, plum, and peach are familiar examples of the *drupe*, or stone-fruit. In this, the outer part of the thickness of the pericarp becomes fleshy, or softens, like a berry, while the inner hardens, like a nut. From the way in which the pistil is constructed, it is evident that the fleshy part here answers to the lower, and the stone to the upper, side of the leaf;—a leaf always con-

sisting of two layers of green pulp, which are considerably different.

NOTE.—The pericarp consists of three parts, the external layer, or coat, called the *epicarp*, the middle the *sarcocarp*, and the inner the *endocarp*; *e. g.*, in the peach the skin is the epicarp the flesh the sarcocarp, and the stone which encloses the kernel the endocarp. Whenever the walls of a fruit are separable into two layers only, the outer layer is called the *exocarp*, the inner the *endocarp*. In *dry-fruits*, the seed-vessel remains herbaceous in texture, or becomes thin and membranaceous, or else it hardens throughout.

54. What is meant by *dehiscence*?

ANS.—The opening of the pericarp to discharge the seed is called dehiscence. Some pericarps do not discharge their seeds, the latter being liberated only by the decay of the pericarp, or by its bursting into germination. Such are said to be *indehiscent*.

55. Name the *modes of dehiscence*.

ANS.—I. VALVULAR, opening vertically, regularly, and either wholly or partially, around the axis, forming several pieces called *valves*. Of these we have four varieties, as follows:

1. *Sutural*, at the sutures of a one-celled or simple pericarp. 2. *Septicidal*, when the separation is between the carpels of a compound ovary. The carpels may then open separately or remain indehiscent. 3. *Loculicidal*, when each carpel opens at its back into the cell. 4. *Septifragal*, when the valves come away from a compound ovary, leaving the partitions (*dissepiments*) or inner walls of the carpels remaining.

II. POROUS, as in the Poppy, where the seeds are discharged by means of orifices at the top of the pericarp.



III. **CIRCUMCISILE**, when the whole top of the ovary comes off like the lid of a box, as in Purslane, the Plantain and Henbane. In *Jeffersonia* or Twin-leaf, the line does not separate quite round, but leaves a portion to form a hinge to the lid.

*Query*.—What is the *Achenium*? To what class of pericarps does *clavio* belong? Name the forms of dehiscent pericarps. Where and how is *digestion* performed in plants? What are *abortive* organs? What are the *sutures* of the pistils? What is meant by the *parietal placenta* of pistils? What is the “organ of respiration” in plants? Describe *latent* buds. In what three ways is the anther attached to the filament?

### 56. Of what does the seed consist?

*Ans.*—Its coats, or integuments, and a kernel. The outer coat is often hard or crustaceous, whence it is called the *Testa*, or shell of the seed. It varies in different plants, being membranous, leathery, bony, horny, woody or fleshy, and sometimes clothed with long hairs (*comae*), as in the cotton plant, sometimes winged, as in catalpa. The inner coat, called the *tegumen*, is thin and delicate, and is often scarcely to be distinguished from the testa.

### 57. What is the *Aril* or *Arillus*?

*Ans.*—It is an additional, but more or less incomplete covering, outside of the real seed-coats, as the *mace* of the nutmeg.

*NOTE.*—The names of the parts of the seed and of its kinds are the same as in the ovule. The scar left where the seed-stalk separates is called the *hilum*. The orifice of the ovule, now closed up and showing only a small point or mark, is named the *micropyle*. The terms *orthotropous*, etc., and those which express the direction of the ovule or the seed in the cell, such as *ascending*, etc. apply to seeds just as they do to ovules.

### 58. What is the *kernel*?

Ans.—It is the whole body of the seed within the coats. In many seeds the kernel is all Embryo; in others a large part of it is the Albumen. The former is the rudiment of the future plant. It is sometimes called the *germ*.

### 58. Describe the *albumen*.

Ans.—It is an accumulation of nourishing matter—starch, etc.,—commonly surrounding the embryo, and destined to nourish it when it begins to grow, as was explained before. It is the floury part of wheat, corn and buckwheat. But it is not always mealy in texture. In Poppy seeds it is *oily*. In the seeds of Pæony and Barberry, and in the cocoanut, it is *fleshy*; in coffee it is *corneous* (that is, hard and tough, like horn); in the Ivory Palm it has the hardness as well as the appearance of ivory, and is now largely used as a substitute for it in the fabrication of small objects. However solid its texture, the albumen always softens and partly liquefies during germination; when a considerable portion of it is transformed into sugar, or into other forms of fluid nourishment, on which the growing embryo may feed.

### 60. What is the *radicle*?

Ans.—A rudimentary stemlet, which is sometimes long and slender, and sometimes very short. In the seed it always points to the micropyle, or what answers to the foramen of the ovule. As to its position in the fruit, it is said to be *inferior* when it points to the base of the pericarp; *superior* when it points to its summit. The base or free end of the radicle gives rise to the root; the other extremity bears the *cotyledons*.

NOTE.—A little seedling, weighing only two or three grains, often doubles its weight every week of its early growth, and in

time may develop into a huge bulk of many tons' weight of vegetable matter. How is this done? What is vegetable matter? From whence did it all come, or

### 61. How does the plant grow?

Ans.—*Growth is the increase of a living thing in size and substance.* The basis of vegetable structure is the cell. In its active condition it is a closed membranous sac containing a fluid and a solid point or *nucleus*. The growth of the plant is simply the multiplication of cells. Cells multiply in some cases with wonderful rapidity, as we see in mushrooms, which reach to a great size in a single night. Though most plants consist of a multitude of cells, a single cell is capable of existing as an independent plant. Diatoms and some species of *Confervæ* consist of single cells.

### 62. How is wood formed?

Ans.—Of cells which at first are just like those that form the soft parts of plants. But early in their growth some of these lengthen and at the same time thicken their walls; these are called *woody fibre* or *wood cells*; others grow to a greater size, have thin walls with various markings upon them, and often run together end to end so as to form pretty large tubes, comparatively; these are called *ducts* or *vessels*.

### 63. What causes the rise of sap into the leaves?

Ans.—To a great degree it is the result of a mode of diffusion which has been called *Endosmose*. Water largely evaporates from the leaves; it flies off into the air as vapor, leaving behind all the earthy and the

organic matters—these not being volatile;—the sap in the cells of the leaf therefore becomes denser, and so draws upon the more watery contents of the cells of the stalk, these upon those of the stem below, and so on from cell to cell, down to the root, causing a flow from the roots to the leaves, which begins in the latter:—just as a wind begins in the direction towards which it blows. Similarly, elaborated sap is drawn into buds or any growing parts, where it is consolidated into fabric, or is conveyed into tubers, roots and seeds, in which it is condensed into starch and stored up for future use.

#### 64. What are the two kinds of wood?

ANS.—THE ENDOGENOUS STEM; so named from two Greek words meaning “*inside growing*,” because, when it lasts from year to year, the new wood which is added is interspersed among the older threads of wood, and in old stems the hardest and oldest wood is near the surface, and the youngest and softest towards the centre. In the EXOGENOUS STEM, the wood is all collected into one zone, surrounding a pith of pure cellular tissue, and surrounded by a distinct and separable bark, the outer part of which is also cellular.

Query.—Is a corn-stalk exogenous or endogenous? What are the *medullary rays*? Describe *acrogenous* and *thallogenous* structures. What is sap-wood, or *alburnum*? What is heart-wood, or *duramen*? What are the five tissues of plants, according to the form and arrangement of the cells? How is sap transferred from one cell to another. Define *plumule*.

#### 65. What are the divisions of *bark*?

ANS.—The *liber*, or fibrous bark; the *cellular*, or outer bark; the green bark, or green layer; and the *corky* layer, *epidermis*, or skin of the plant, consisting of a layer of thick sided, empty cells, covers the whole.

## 66. What gives the green color to leaves?

Ans.—It is owing to a peculiar green matter lying loose in the cells, in form of minute grains, named *Chlorophyll* (i. e., the green of leaves). It is this substance, seen through the transparent walls of the cells where it is accumulated, which gives the common green hue to vegetation, and especially to foliage.

## 67. What three elements must the plant's food contain?

Ans.—Hydrogen, oxygen, and carbon. Water, which it takes in vastly more than anything else, is composed of the first two elements, and it derives the third from carbonic acid, one of the components of the atmosphere. The latter they take in by their leaves and roots. So water and carbonic acid, taken in by these means and carried up to the leaves as *crude sap*, are the general food of plants.

## 68. What is said of motion in plants?

Ans.—The so-called *sleep of plants* is a change of position as night draws on, and in different ways, according to the species,—the Locust and Wood-Sorrel turning down their leaflets, the Honey Locust raising them upright, the Sensitive Plant turning them forward, one over another,—and the next morning they resume their diurnal position. The leaves of our Wild Cassias, which open their yellow flowers in August, are very sensitive, closing their numerous leaflets when touched. At Aspinwall, the traveller, first stepping from the car into a dense green patch of Mimosa, is confounded at seeing the whole patch disappear, leaving the ground almost bare, and again after a



few minutes looking as verdant as ever! The Venus's Fly-trap of North Carolina grows where it might be sure of all the food a plant can need, and yet it is provided with an apparatus for catching insects, which it does by an expert and sudden motion.

### 69. What are the two Series of flowers?

ANS.—The *Flowering or Phænogamous Plants* and the *Flowerless or Cryptogamous Plants*. Thus the vegetable kingdom is parted into two sub-kingdoms, known by the presence or absence of visible flowers. This division was first recognized A. D. 1682, by John Ray, of England.

NOTE.—The universal members of classification are CLASS, ORDER, GENUS, SPECIES, always standing in this order. When there are more, they take their places as in the following schedule, which comprises all that are generally used in a natural classification, proceeding from the highest to the lowest, viz:

Series,  
     CLASS,  
         Sub-Class,  
             ORDER, OR FAMILY,  
                 Sub-Order,  
                     Tribe,  
                         Sub-Tribe,  
                             GENUS,  
                                 Sub-Genus, or Section,  
                                     SPECIES,  
   Variety.

### 70. What is the botanical name of a plant?

ANS.—It is that by which a botanist designates it, and is the name of its genus followed by that of the species. The name of the genus or kind is like the family name or surname of a person, as *Smith*, or *Jones*. That of the species answers to the baptismal name, as *John*, or *James*. Accordingly, the White Oak is called botanically *Quercus*

*alba*; the first word, or *Quercus*, being the name of the Oak genus; the second, *alba*, that of this particular species. The botanical names are all in Latin (or are Latinized), this being the common language of science everywhere.

### 71. How are other *genera* named?

ANS.—By bearing the names of distinguished botanists or promoters of science: such as *Jeffersonia*, named after President Jefferson, who sent the first exploring expedition over the Rocky Mountains. The Apple Moss is known in science as *Bartrámia*, a name conferred by Linnæus, in honor of John Bartram, a Pennsylvania farmer.

NOTE.—The name of the species sometimes relates to the country it inhabits, as *Sanguinaria Canadensis*, from Canada; more commonly it denotes some characteristic trait, as *Sarracenia purpurea*, from the purple blossoms. Some species are named after the discover, or in compliment to a botanist who has made them known; as, *Raworthia Michauxii*, for the botanist Michaux.

### 72. How do the groups derive their names?

ANS.—The names of tribes, orders, and the like, are in the plural number, and are commonly formed by prolonging the name of a genus of the group taken as a representative of it. For example, the order of which the Buttercup or Crowfoot genus, *Ranunculus*, is the representative, takes from it the name of *Ranunculaceæ*; meaning *Plantæ Ranunculaceæ* when written out in full; that is, Ranunculaceous Plants.

### 73. How do we analyze plants?

ANS.—By asking first whether it is *flowering* or *flowerless*. If the former, to which of the two classes does it belong? If we judge by the stem, we ask whether it is

exogenous or endogenous. To which sub-class is the next inquiry. The ovary tells us this. By the aid of a *Manual* we trace its divisions and sub-divisions, and after several analyses of this kind, the student will be able to pass rapidly over most of these steps; he should ordinarily recognize the class and the division at a glance, for the study of one plant leads naturally and easily to the knowledge of the whole order or family of plants to which it belongs.

74. Give the form of analysis of a leaf.

ANS.—*Life*. Are the leaves deciduous or evergreen?

*Place*. How are they folded in vernation?

What is their position on the plant?

How are they arranged among themselves?

*Construction*. Describe their veins and vernation.

Of what numbers are they constituted?

Are they simple, or compound?

Describe the mode of composition. [outline?

*Form of blade*. What term or terms define their

What term defines the apex, or the base?

The margin—is it dentate, serrate, or what?

*Size*. State their measurements. [ing.

*Quality*. Describe their surface-quality, or cloth-

75. Indicate the signs used in descriptive botany.

AN.—(1) An annual plant. (2) A biennial plant. 2 ♀ A perennial plant. ♂ A plant with a woody stem. ♀ A pistillate flower or plant. ♂ A perfect flower, or a plant bearing perfect flowers. ♂ Monœcious, or a plant bearing staminate and pistillate flowers. ♀ ♂ Dioecious; pistillate and staminate flowers on separate plants. ♀ ♂ ♂ Polygamous; the same species, with pistillate, perfect,

and staminate flowers. 0 (a cipher), signifies wanting or none; as, "Petals 0." § (placed after); a naturalized plant. † (placed after); cultivated for ornament. ‡ (placed after); cultivated for use. ∞ Indefinite or numerous; although if the stamens are carefully counted, they will generally be found some multiple of 5; as 25, 30, etc. ♂ A staminate flower or plant.

Query.—How much is a *line*? What are *leguminosæ*? *umbelliferæ*? *compositæ*? What are the "inorganic materials" of plants? Define *proteine*. When is a plant *diclinous*? What is the *pleureuchym*? How can a knowledge of plants best be obtained? Name the parts of a perfect flower.

NOTE.—Chocolate is so called from *chocolalt*, the Mexican name for the cacao-tree. The produce of several of the finest kinds is not exported; the best that reaches us is from Caraccas, Guatemala, and Berbice. The method of preparation is as follows: The cacao-leaves are gently roasted, shelled, and reduced to a paste, when vanilla, cloves, cinnamon, rice, almonds, or starch, etc., are frequently added to it; it is put into moulds, and always improves by keeping. The Nectarine is a fruit resembling the peach, but with a smooth rind. It is a native of Persia, and was introduced into Europe from that country in the year 1562. The mode of cultivation is almost identical with that pursued with the peach, with which it is usually classified. Give descriptions of Prunes, Raisins, Papaw, Jujube, Dates, etc.

76. Give an analysis of the Anemone.

Ans.—

Organ.	Life, Habit, Number, Place, Dehiscence, Kind, Construction, Form, Placentation, Size, Qualities, Appendages.
Plant, L. H. S. Q.	4, herb 6-10' high, generally smooth.

Root, L. K.	24, oblong, starchy tubers, with fibres attached.
Stem, L. H. K. F.	Annual, are erect, simple, terete caulis.
Leaves, L. P. C. F. S. Q.	1, radical, biternate; 2, cauline, ternate, sessile, 1'fts; 3 lobed.
Inflorescence, P. K. A.	Terminal, umbellate, involu- crate.
Flower, N. C.	3-7, regular, apetalous, hypo- gynous.
Calyx, F. Q.	Rose form, petaloid, white.
Sepals, L. N. P. F.	Deciduous, 5-10, spreading, elliptical, imbricated.
Corolla, F. Q.	None.
Petals, L. N. P. F.	None.
Stamens, N. P. C.	8, hypogynous, distinct, fila- ment club shaped (clavate).
Anther, D. C. F.	Oval, 2-lobed, opening later- ally, innate.
Style, N. C. F.	None, or very short.
Stigma, N. F.	6-10, sessile, simple.



Ovary, C. F. Pn.	Distinct, simple, oblong, with 1 suspended ovule.
Fruit, N. D. K. F. Q.	Achenia 6-10, smooth, fluted, ovoid.
Seed, N. C. F. Q. A.	1 in each carpel, albuminous, emb. 2-lobed.

Locality—Woods, Monroe, Mich., (Date) May 11, 1862.

Classification—PHENOGAMIA; Exogens.

Order—Ranunculaceæ, or the Crowfoots.

Name—Latin, *Anemone thalictroides*.

—English, Rue Anémone.

Remarks—*The caudine leaves serve as an involucre.*

NOTE.—A simple form of analysis is given in Holbrook's Plant Record, which may be used to advantage by the young student. Underwood's Systematic Plant Record, a blank-book admirably arranged, will be found almost indispensable for class and private use.

77. Name some of the common plants belonging to the Pulse Family.

ANS.—Beans and Peas, Wild Indigo, Vetch, Red Bud, Senna, Locust, Sweet Clover, Kentucky Coffee-Bean, and Sensitive Plant

78. What is the name of the common Tulip?

ANS.—*T. (Tulipa) Gesneriana*, being dedicated to Gesner, [a Swiss botanist, who saw it blooming in a garden in Augsburg, and first made it public in 1559. The name tulip is from a Persian word signifying a *turban*, whose gay colors it resembles.

NOTE.—The taste for cultivating the Tulip spread into the Netherlands, and about 1634 increased to such an extent that all classes began to speculate in the bulbs. Houses and lands were sold to be invested in flowers. Ordinary business was neglected. Sudden fortunes were made. Nobles, mechanics and chimney-sweeps alike, flocked to the tulip market. Prices increased until a single bulb (the *Semper Augustus*) sold as high as \$6,000 of our present money. At last this tulip rage ran its course. Prices suddenly fell. The rich of yesterday became the poor of to-day. A commercial crisis ensued. Holland did not recover from the "Tulip mania" for many years. The love for this flower still exists in that country. We import our best bulbs from Holland, and the wealthy Dutchman boasts of his fine tulips, as a rich Englishman does of his horses or paintings.

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### Notes and Tests.

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*The Process of Fertilization.* The pollen falls upon the stigma, expands or lengthens into a tube which penetrates the *style*, until it reaches the *embryo sac* of the ovule where by some mysterious process it causes the development of the ovule into a perfect seed, capable of germination and reproduction. It is the opinion of Schleiden that the end of the pollen tube itself becomes the embryo of the new plant and is only quickened by the embryo sac, which acts as a receptacle or nest for it. Why must the pollen be lodged on the stigma? As in many cases the anthers are below the stigma or, as in the case of the Iris, they are *extrorse*, that is, opening and discharging their pollen outward—averse from the stigma—the question will arise, How does the pollen reach the stigma? Insects are the most common conveyors of pollen, as they roll themselves in the flower of one plant, and then fly to another bearing the pollen adhering to the down of their bodies. In some cases the pollen is conveyed by the winds. The Touch-Me-Not is a representative of what

family? To what family does the Almond belong? What is the time of opening of the *primrose*? of the *goatsbeard*? the *marigold*? What is the hour of closing of the *dandelion*? of the *primrose*?

“ ’T was a lovely thought to mark the hours,  
As they floated in light away,  
By the opening and the folding flowers  
That laugh to the summer’s day.

MRS. HEMANS.

What are Cohorts and Sub-kingdoms? Describe the roots and rootlets. What is the *cambium-layer*? Name some distinguished botanists. What is metamorphosis? Define transpiration. What is “true sap”? What is a *dicotyledonous embryo*? Describe the “cellular tissue.” What is meant by the alternation of parts in the flower? Define *gluten*. What is an *involucre*? What is *chaff*? Name all the parts of a plant, and give the functions of each. Besides furnishing food for men and animals, what are the most important uses of plants? How can æstivation best be seen? What is Phylotaxy? What is meant by *spadix* and *spathe*? Describe a labiate flower. Illustrate the difference between a simple and a compound leaf. What is a Corm? Define Morphology? What plant produces 66 millions of cells in a minute? Give some examples of the Orchidaceæ. If leaves are the lungs of a plant, how do leafless plants respire? What are Stomata or Stomates? What is the typical form of a cell, and what are its contents? What part of botanical study is adapted to primary schools? Why? What is your method of teaching botany? Give some account of the geographical distribution of plants? What is the Funiculus? How is the five-ranked arrangement expressed? How is assimilation produced? What are bractlets? Describe the *germ*, Define naked and scaly buds. What are *deliquescent stems*? What is an *excurrent*

*trunk?* Have you read of the "big trees" of Calaveras Grove? Of what is the Palmetto an emblem? What is derived from the "dragon-root"? What is Saffron? What are *monocarpic perennials*? Name the 8 species of Trilliums? Tobacco belongs to what family? What is the "silver grain"? To what order does the Cowslip belong?

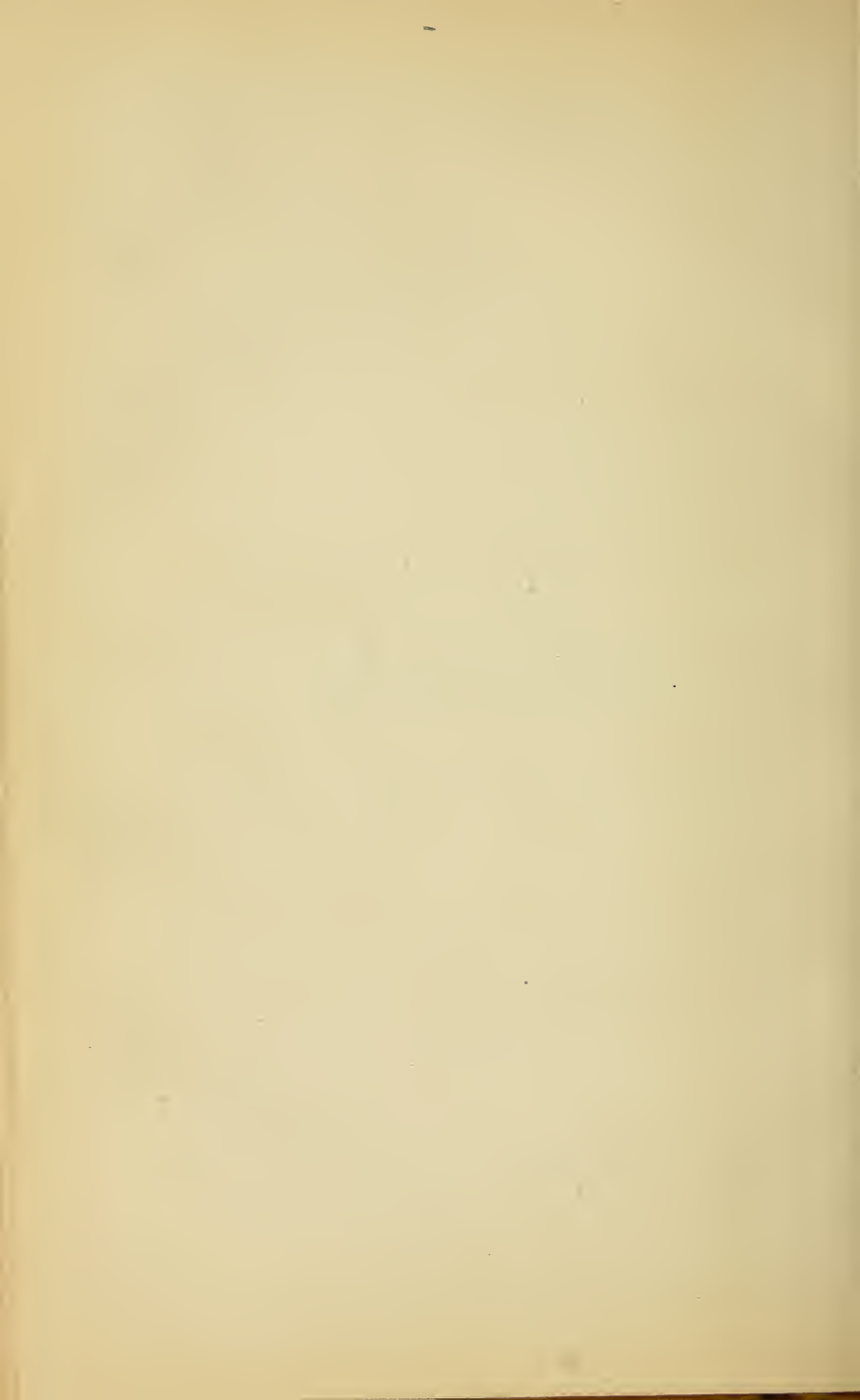








# ZOÖLOGY.



# ZOÖLOGY.

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## 1. Define Zoölogy.

Ans.—Zoölogy (*zoon*, animal; *logos*, discourse) is the science which treats of animals. It includes every kind, from a whale to the tiniest microscopic creature. Special divisions of the animal kingdom form the matter for large treatises, and thus we have various sciences subordinate to Zoölogy, as Ornithology, Ichthyology, Herpetology, Entomology, etc.

NOTE.—Natural History, in its broadest sense, is the science which treats of the earth and of all natural objects upon its surface and within its crust. The term, however, is too often used in a restricted sense as meaning the same as Zoology. In addition to Zoology, Natural History also includes Botany, Geology, and Mineralogy.

## 2. What is the difference between plants and animals?

Ans.—*Animals* are living beings which are built up wholly by *organic* food—that is, by vegetable and animal materials—have sensation and the power of voluntary motion, and consume oxygen and give off carbonic-acid. *Plants* are organisms which are endowed with life, probably as real as that of animals, and perhaps differing from that of the latter only in degree; but, unlike animals, they are sustained and built up by *inorganic* nutriment—that is, by earthy materials, water, and gases—and they consume carbonic acid and give off oxygen. The Insect-eating plants are an exception.

NOTE.—As to the relations of oxygen and carbonic acid to living plants and animals, it must be stated here that the definitions given above have to be modified by the fact that Wohler claims to have shown that some kinds of the Infusoria give off oxygen instead of consuming it, as is done by animals in general; and that Schlossberger and Dopping claim to have shown that some kinds of mushrooms exhale carbonic acid instead of consuming it, as is done by most species of plants.

### 3. What is said of the line of separation between Animals and Plants?

ANS.—In view of the great difficulty in drawing an exact line of separation between Animals and Plants, Hæckel has recommended the recognition of an intermediate Kingdom, to be called the *Regnum Protisticum*, in which all organisms shall be included which cannot with certainty be referred either to the Animal Kingdom on the one hand, or the Vegetable Kingdom on the other. *Regnum Protisticum* literally means the kingdom of simplest organisms. As it is not yet proven that there is really any such intermediate kingdom in nature as is here suggested, the recommendation of Hæckel cannot at present be adopted.

### 4. Give the classification of animals.

ANS.—The entire animal kingdom is divided into *SUB-KINGDOMS* based upon a general common plan of structure. Each sub-kingdom is again divided into *CLASSES*, based upon general physiological characters. Each class is divided into *ORDERS*, based upon still more particular structure. Each order, in regarding the characteristics of its individuals with regard to their general form, is divided into *FAMILIES*. And each family, with regard to details of execution in special parts, is divided into *GENERA* (sing., Genus). Each genus is divided into *SPECIES*, embracing



all animals which have descended from a common ancestor. Species are sometimes divided into *varieties*, based upon certain points of resemblance.

5. Name the grand divisions or sub-kingdoms of animal life, giving the characteristics of each.

Ans.—Cuvier recognized four great Branches or Types in the Animal Kingdom—the Vertebrata, the Articulate, the Mollusca, and the Radiata. Zoölogists of a later day added a fifth branch, the Protozoa, but Steele's classification which probably represents the views of a majority of naturalists gives six sub-kingdoms, viz., Vertebrates, comprising all animals which have a vertebral column or back-bone; Articulates, containing those having a jointed body and limbs; Molluscans or Mollusks, soft-bodied, but usually protected by a shell; Echinoderms (spiny-skinned), distinct from body-cavity; Coelenterates (hollow-entrained), not distinct from body-cavity; and Protozoans (first animals) very minute and of simple structure.

NOTE.—The first three divisions include animals with a nervous system; the fourth and fifth were formerly assigned to the single sub-kingdom of Radiates.

Query.—What is a Species? Define the terms *breed*, *races*, *mongrel*, and *hybrid*. In what way can the first lessons in animals be made most profitable and interesting? Name the points distinguishing animals from plants. What are the 8 systems of organs? What are the modes of reproduction?

6. What are the general characteristics of the vertebrates?

Ans.—They are usually distinguished by a chain of small bones (*vertebræ*) to which the other parts of the skeleton are attached; possess a brain, spinal marrow, ganglions, etc.

## 7. Name the five classes of vertebrates.

ANS.—1. Mammals. 2. Birds. 3. Reptiles. 4. Amphibians. 5. Fishes. The first are *viviparous* (producing living young). The remaining four are *oviparous* (producing eggs).

## 8. Describe the Mammalia.

ANS.—The distinguishing features are that they suckle their young, and that their bodies have, in general, a full or partial covering of hair. Their respiration is simple; blood, red and warm; circulation, double and complete; five senses, and heart four-chambered.

## 9. How many orders have the mammalia?

ANS.—Fourteen; each with distinguishing characteristics. Bimana, (man); Quadrumana, (monkey); Carnivora, (cat, dog); Ungulata (horse); Hyracoidea, (daman); Proboscidea, (elephant); Sirenia, (manatee); Cetacea, (whale); Cheiroptera, (bat); Insectivora, (mole); Rodentia, (rat); Edentata, (sloth); Marsupialia (opossum); Monotremata, (duckbill). To this Tenney adds Toxodontia (gigantic quadrupeds, now extinct, having bent teeth).

## 10. To what order does man belong?

ANS.—This order comprises only one family, and embraces a single genus and species.

{ Order.	Family.	Genus.	Species.	Example.
{ Bimana.	Hominidæ.	Homo.	Sapiens.	Man.

The peculiarities which distinguish man from the other mammals are the position of the spinal opening in the middle third of the base of the skull, thereby balancing the head and admitting an upright posture; the ability of opposing the thumb to the fingers; an erect position; pro-

gression on the legs; he is plantigrade (walking on the sole of the foot); the relatively great development of brain; is endowed with the power of making the sounds of the voice into words; is cosmopolitan, etc.

NOTE.—By general consent of zoologists, the names of all Families terminate in *idae*, which are expressed by adding this termination to some case-form of a principal genus of the family. Generally [names are from the Latin and Greek, and usually express some characteristic of the animal. Names of species are formed, as in Botany, from the locality, name of distinguished naturalist, or scientist, etc.

11. What are the three families of quadrumana?

ANS.—*Simiidae*, Monkeys of the Old World; *Cebidae*, monkeys of the New World; and *Lemuridae*, monkeys of Madagascar. The first named has the two divisions of Anthropoid Apes (without tails), and Monkeys Proper (with tails). Of those without “posterior callosities” are the three following:

GENUS.	SPECIES.	EXAMPLES.
Troglodytes,	Niger,	<i>Chimpanzee</i> .
Troglodytes,	Gorilla,	<i>Gorilla</i> .
Simia,	Satyrus,	<i>Orang-outang</i> .
(Snub-nosed satyr).		

12. Which bears the greatest resemblance to man?

ANS.—The *Chimpanzee*, though inferior in stature and strength. Like the Gorilla, it has its home in the dense forests of Western Africa. Both have been represented as dwelling in huts built in trees, and snatching up the

unwary traveller who passes beneath; whereas, they generally remain upon the ground, eat fruit and vegetables, and merely bend down branches for a seat, and, perhaps for concealment.

### 13. Describe the Ateles.

ANS.—A representative of the Cebidæ with prehensile tail. Has four fingers, but no thumb on the anterior extremity. On account of the length, flexibility, and slenderness of its limbs, it is termed the *Spider Monkey*. The end of the tail is bare and sensitive, and can be used as a fifth hand to pick up small objects, or to insert into the hollows of trees to hook out eggs.

NOTE.—When the Ateles wish to cross a river, the strongest ascend a high tree overlooking the stream. The leader, hooking his tail firmly to a limb, drops downward, while the next attaches himself to his predecessor, and so on, forming a long chain of monkeys. This swings to and fro until the end monkey grasps a limb upon the opposite bank. Along this living suspension bridge the troop pass over, a mischievous monkey occasionally playing off a practical joke on some member as he hurries forward. To get the bridge across, the first monkey lets go and the chain swings over, perhaps ducking one or two, when all unfasten and catching at the branches descend.

### 14. What is the meaning of "Lemur"?

ANS.—It means spectre, and is descriptive of the nocturnal habits and stealthy step of the animal. In fact, it is known among sailors as the "Madagascar Cat." The *Ruffed Lemur* is the largest and handsomest specimen of the Lemuridæ. Wrapped up in its long, bushy tail, it passes the day in sleep, and only comes forth at night to search for food. The *Aye Aye* has some resemblance to a squirrel, but the form of its head and limbs allies it to the

**Lemur.** The middle finger of its fore-leg, long, slender and hairless, is adapted to extract worms from their holes in the ground or in trees.

**NOTE.**—Of the tailed monkeys of the Eastern Hemisphere, some of the most interesting are the Semnopithecæ, or Solemn Apes, of Asia and the Asiatic Archipelago, one of which, the Kahau, is celebrated for its very long nose; the Guenons, which move in large troops and commit great havoc in fields and gardens; the Macacos, which have shorter limbs and longer muzzle than the Guenons; and the Barbary Ape that inhabits the precipitous sides of the Rock of Gibraltar. The Catarrhines also include all the quadrumana known as Baboons, and are the ugliest and most ferocious of all the monkey tribes. They have the muzzle much lengthened, and are often called Dog-headed monkeys and Mandrills. They belong mainly to Africa and the Phillipine Islands.

### 15. Describe the Carnivora.

**Ans.**—They are *flesh-eating* mammals, with sharp, jagged teeth, fitted for cutting food, strong, and have usually sharp claws; are divided into three sub-orders, according to method of locomotion: (1) Digitigrades, (2) Plantigrades, (3) Pinnigrades, or Pinnipedia. The families of (1) are: *a*, Cats, which catch their prey by springing upon it, generally at night; claws very sharp, retractile. *b*, Dogs, which chase their prey, catching it with the teeth; claws not sharp, non-retractile. *c*, Hyenas, with long fore legs, and powerful jaws. *d*, Minks, generally slender-bodied, emitting a peculiar odor, and living largely upon the blood of their victims: Skunks, Badgers, Otters, etc. (2) includes *e*, Bears and Raccoons, which live partly upon vegetable food; and *f*, Civet Cats. Under (3) are *g*, Eared Seals, *h*, Common Seals, and *i*, Walrus, distinguished by its tusk-like upper canine teeth.

16. Give a descriptive outline of the “King of Beasts.”



Ans.—Sub-Kingdom,—(Vertebrata.)

Class,—(Mammalia.)

Order,—(Carnivora.)

Family,—(Felidae or Cat Family.)

Genus,—(Felis or Cat.)

Species,—(Leo or Lion.)

NOTE.—The *Lion* is known by this appellation, more from his majestic appearance than from any nobleness of disposition. In fact, Livingstone and Gerafd pronounced him cruel and cowardly. He secures his prey by lying in ambush till it comes within reach of his terrible bound, and if the first spring fails, like the tiger, he sneaks back to his covert ashamed and disappointed. His speed is too slow to permit his overtaking his game.

### 17. What is the Felis Tiger?

Ans.—Another member of the “cat family” which, being destitute of a mane and tail-tuft, lacks the noble bearing of the lion, but is beautifully decorated with black stripes upon a ground of reddish-yellow fur tending to white beneath. Its ferocity, especially that of the dreaded “man-eater,” is fearful, while its strength enables it to carry off a buffalo thrown over its shoulder. Inhabiting Southern Asia, its home is in the long jungle-grass, with the coloring of which, its stripes so exactly assimilate, that it is impossible for unpractised eyes to discern it at even a short distance. This adaptation of the color of an animal to that of surrounding objects in its native wilds is termed *mimicry*, and is one of the most most wonderful provisions of nature.

Query.—What is the “dental formula” of man? Define the terms Monodelphia, Didelphia, and Ornithodelphia? What is the *facial angle* of the dog? of man? the negro? the Caucasian? What is the meaning of Quadrumana? Give the technical name for “broad-nose.” How does the *Siamang* monkey derive its specific name?

## 18. What is said of Lynxes?

Ans.—These cats have the tail very short, and they have one molar less than the true cats in each side of the upper jaw. As examples of this kind, we may mention the Canada Lynx, which is about forty inches in length, and of a grayish hoary color waved with black, the ears tipped with a pencil of black hairs; and the American Wild-Cat (*Lynx rufus*), which is about thirty inches long, of a pale rufous color overlaid with grayish, and whose ear is black on the outside and has a white patch, while the tail has a black patch above at the end.

## 19. Describe the Hyenas or Hyenidae.

Ans.—Of all the Carnivora none are uglier in their general appearance. Their fore-legs are longer than the hind ones, the claws non-retractile, the feet four-toed, and the tongue rough. Their premolars are very large and blunt; these animals are able to crush the bones of very large animals, and swallow the fragments without masticating them. So powerful are the muscles of the neck and jaws that it is next to impossible to wrest anything from between their teeth.

## 20. What animal changes color?

Ans.—The *Weasel*, which at the north, during summer, is reddish-brown above and white beneath. It changes from brown to white in October and November, and back again in March, except the extremity of the tail, which is always black. At the south, the same species does not vary its fur. These alterations are effected, not by shedding the coat, but by changes in the color of the hair. The expression "catch a weasel asleep" is based upon the ease with which the animal may be caught when sleeping, on account of the soundness of its slumbers.

21. What is the "*ursus horribilis*?"

Ans.—The Grizzly Bear, which inspires such fear that no other animal dares to touch a deer that it has killed and left behind; the simple point of the bear's foot frightening away even a hungry wolf.

## 22. What is the order Herbivora?

Ans.—The name of the term including Ungulata, Hyracoidea and Proboscidea: all herb-eating animals with teeth fitted for grinding food. The Ungulates are even-toed (*artiodactyls*) and odd-toed (*perissodactyls*) and are divided into the following classes: *a*. Camels, two toed Ruminants (animals that have four stomachs and remasticate the food after swallowing it) with generally a hump of fat upon the back, the toes united nearly to the tip, and cells which hold water in the lining of the stomach, *b*. Giraffes, with long necks and two short permanent horns. *c*. Oxen, with permanent hollow horns ensheathing bony cores; Antelopes, Goats, Sheep, etc. *d*. Prong-horn Antelopes, horns hollow, pronged and deciduous. *e*. Deer, horns solid, deciduous and branching; Elk, Reindeer, etc. (All the above are ruminants, *c*, *d*, and *e*, have the upper incisors wanting.) *f*, Hippopotami. *g*, Hogs and Peccaries, covered with bristles, and nose fitted for rooting. *h*, Horses, one-toed ungulates. *i*. Rhinoceros, three-toed, skin in folds, and one or two horns upon the top of the muzzle. *k*, Tapirs, having short proboscis.

## 23. What is the difference between a Dromedary and a Camel?

Ans.—The first has one hump, the Bactrian Camel has two. The former is adapted to hot climates while the latter frequents cold regions of the earth. The Llama, the third

member of the *Camelidae* family, is of small size, and has no humps. Camels have two toes, united nearly to the point by the callous sole. To adapt the llama to its home in the Andes, its cushioned toes are completely divided, and its nails project so as to hook downward, and give it a fearless step among the crags.

NOTE.—The camel, poetically called by the Arab the “ship of the desert,” constitutes his wealth. Its milk, and often its flesh, furnishes him food; its skin, leather; its hair, clothing; its excrement, fuel; and, in an extremity, the water in its stomach will save his life. It will carry 600 and even 1000 lbs. burden. A swift dromedary will travel 10 miles per hour for 20 hours on a stretch. Its gait has a peculiar swinging, jerking motion that is terribly trying to the novice. Its disposition is said to be naturally gentle, but the brutality of its drivers often renders it ugly. Thus says a traveller: “Watch it when it is being loaded. See its keeper struggling frantically, and making it kneel only by sheer force, and when down, keeping it there by tying neck and fore legs together tightly. Hear it grumbling in deep, bubbling tones, with mouth savagely opened as each new burden is laid on its back. Look how it refuses to rise until a part is removed; then see it get up—a great, brown mountain, still groaning and bubbling—and dash to and fro, shaking off beds, furniture, and trunks in a shower. Mark it, subdued by blows, march through the day, occasionally biting at a passer-by, and at night kneel to have its load removed, grumbling as ever. Certainly not the picture of our ideal patient animal.”

Query.—What animal is noted for the “golden tint of its skin?” Which one never perspires? Name the members of the *Canidae* or Dog Family. What animal indulges in the pastime of sliding down snow-banks in winter and clay-banks in summer? What one furnishes the choicest seal fur? What cervical vertebrae has the Giraffe in his long neck?

## 24. Describe the Deer.

ANS.—Deer is the common name applied to a very extensive group of ruminating animals, varying in size from the small Muntjac of Eastern Asia to the gigantic Moose

of North America which is now becoming extinct. The group is characterized in most genera by solid horns in the males, falling off annually in the large species and, when first developed, covered with a hairy skin. They are found in all parts of the world except Austrailia, and are valuable (besides furnishing food and clothing) as draught animals in many cases.

### 25. Describe the growth of the horns.

ANS.—In the young animal, a kind of hard, bony lump is at first observable, on each side of the frontal bone; this grows rapidly, pushing the skin with it. When the horns are fully developed, the skin envelope falls, leaving them hard and bare, when they also fall off and are reproduced; at each successive growth the horn increases in size and complexity, but its duration is the same. When the horns fall, the buck retires into the thick forest, not showing himself among the females until his head is re-furnished. The origin of the horn is called the *burr*, the main shaft, the *beam*, and the branches, the *antlers*; the latter, if near the head, are "brow antlers"; if near the middle of the beam, median, or "bez antlers."

### 26. Does the whale spout?

ANS.—Close observers maintain that the whale in breathing never spouts water from the nostrils as the ordinary pictures represent. When it rises to the surface, a foot or more of water over the head is blown away by the breath escaping from the lungs. This is followed by the vast body of air expelled, surcharged with moisture hot from the lungs, which, cooling, changes to vapor, and in its circling descent resembles a shower of spray.



NOTE.—The term Mutilata is sometimes used, including the two orders of Sirenia and Cetacea.

## 27. How is whalebone derived?

ANS.—From the Greenland or right whale, and is not bone, but slabs of horn-like material sometimes ten feet in length, hanging from the upper jaw, and serves to strain out the minute animals on which it feeds. The sperm whale has an immense cavity in the head, containing an oil which hardens and forms the spermaceti of commerce. Ambergris is a peculiar product used in making perfumery, and is sometimes found to the amount of forty pounds in the intestines of the sperm whale. It is thought to be a product of disease.

## 28. What is the Cheiroptera?

ANS.—That order of mammals whose anterior limbs are extended and covered with a membrane, thus being adapted for flight. There are over 30 genera and 200 species of the "bat," the Flying Fox of Java being the largest. Its body, the size of a squirrel, with wings five feet across, is used as an article of food.

NOTE.—Insectivora, or Insect-Eaters, include the kabung, mole, shrew, golden mole, and hedgehog. Their teeth are of three kinds, incisors, canines, and molars, and the latter are studded with acute points. Many of these animals pass into a torpid condition during the coldest part of the year. The hedgehog and bat fall into so deep a stupor that no signs of breathing can be detected; and in a bat's heart the pulsations fall from 200 in a minute to 30 in a minute during torpidity.

## 29. Describe the Rodentia.

ANS.—They have teeth especially fitted for gnawing, two long incisors in each jaw, enameled in front, molars

with transverse enameled ridges. The principal families are *a*, Jumping Mice. *b*, Rats and Mice. *c*, Pouched Gophers. *d*, Beavers. *e*, Squirrels, Gophers, Prairie Dogs, Woodchucks. *f*, Porcupines. *g*, Hares—four upper incisors; cheeks lined with fur, and under surface of feet covered with hair.

### 30. What is the meaning of Edentata?

Ans.—Toothless; they are related only negatively by being destitute of incisors. The chief representative of this order is the Giant Ant-Eater of South America. Its jaws are a foot long, and it can thrust forth its worm like tongue to a distance of two feet as often as twice a second. With its fore feet, armed with powerful nails, it tears open an ant-hill, when the bewildered inmates rush out, and, sticking to its tongue, are rapidly swept into its mouth.

### 31. What is said of the Armadillo?

Ans.—Its legs are very strong, and Wood relates that he has seen an Armadillo running around with ease carrying three monkeys that had chosen to take a ride. When caught, though so small, it will kick with great effect. Some varieties will burrow so fast that it is said the animal will sink out of sight before a man on horseback seeing one, can dismount and catch it. In Paraguay, the natives detect the presence of an Armadillo in its hole by thrusting down a stick, when, if it is there, a swarm of mosquitoes will fly buzzing out.

### 32. Describe the Marsupials.

Ans.—The young are brought forth in an exceedingly immature state of development; and in most cases are

received into a pouch or sack which is situated on the abdomen of the mother. In this living cradle they are nourished by milk till they have acquired a degree of development corresponding to that in which other mammals are born. Even after they are able to walk, the young resort to the pouch of the mother for safety in time of danger. With the exception of the Opossums, found in America, this order is confined to Australia and the adjacent islands.

### 32. What are the Monotremata?

Ans.—The connecting link between mammals and birds. The two well-marked forms are the Porcupine Ant-Eater, and the Duckbill or Water Mole, which caps the climax of the eccentric Australian zoölogy. This animal is covered with brown fur, and has a long, flat muzzle very similar in its appearance to that of a duck. The fore feet have a web extending beyond their extremities, which can be folded up when the feet are used for burrowing, or expanded when employed in swimming. The hind feet are webbed only to the base of the nails.

Query.—What is the difference between a Bison and a Buffalo? What animal is sometimes called the Unicorn? The Durham, Jersey, and Ayrshire are three noted breeds of what? To what family does the hog belong? What are the forms of deers' horns? Is there an Arabian breed of horses? Can the Zebra be domesticated? What is the "herbivorous whale?" What animal is supposed to have a sixth sense?

### 34. What are Aves?

Ans.—Birds, which constitute the second class of vertebrates. They are divided into fifteen orders as follows: Passeres, (Thrush); Picariae, (Woodpecker); Psittaci, (Parrot); Raptores, (Falcon); Columbæ, (Dove); Gallinae,

(Turkey); Brevipennes, (Ostrich); Limicolae, (Plover); Herodiones, (Heron); Alektorides, (Rail); Lamellirostres, (Duck); Steganopodes, (Pelican); Longipennes, (Gull); Pygopodes, (Loon); Sphenisci, (Penguin).

NOTE.—Some authorities include the second and third classes under the general term *Scansores*. The fifth and sixth are also arranged under the head of *Rasores*, while the last five may be classified as *Natatores*, i. e., swimming birds, with webbed feet and short legs, fitted for locomotion in water. It is well to remark, however, that the classification of birds is unsettled. Ornithologists have not as yet agreed even upon the number of orders.

### 35. What is the *mandible* of birds?

ANS.—The upper jaw, which is so articulated with the cranium that it can move independently of the lower jaw; a peculiarity which is not found in the mammalia.

NOTE.—The *bones* are light. The hollowness and the cavities are produced by the removal—by absorption of bony tissues previously formed. Owen says: “The thinnest-walled and widest air-bone of the bird of flight was first solid, next a marrow-bone, and finally became the case of an air-cell.”

### 36. How do birds breathe?

ANS.—Respiration takes place not only in the lungs, but also in the substance of the other organs; the air penetrating into the interior of the bones and feathers, sometimes even to the toes. So complete is this second process, that it is said *a bird will breathe through the end of a broken bone when the windpipe is tied*.

### 37. Give a description of the Robin.

ANS.—“*TURDUS MIGRATORIUS*, *Robin*, American Red-breast. Tail slightly rounded; above olive gray; top and

sides of the head black, chin and throat white; eyelids and a spot above the eye, anteriorly white; under parts and inside of the wings chestnut-brown; the under tail-coverts and tibiae white, showing the plumbeous inner portions of the feathers; wings dark-brown; the feathers all edged more or less with pale ash; tail still darker, the extreme feathers tipped with white; bill yellow, dusky along the ridge and at the tip. Length 9.75; wing 5.43; tail 4.75; tarsus 1.25 inches. Habitat, whole of N. A."

38. Give an example of the Laniidae.

ANS.—The *Shrike* or Butcher-bird, which devours the larger insects and smaller birds after striking them senseless by one blow upon the head with its powerful toothed beak.

39. Which is the largest of the Corvidae?

ANS.—The Raven, which is about two feet long and readily distinguished from the Crow, not only by its larger size, but by the feathers of the throat, which are long, acute and separated.

NOTE.—The Raven is generally considered to be of evil omen. It is easily tamed and taught to repeat sentences. Pliny tells of one which was accustomed to stand in a public place in Rome, and call out the name of every passer-by. There is a story related of an awkward horseman who fell from his seat, and at that moment a raven in the tree above cried out, with its solemn voice, "How silly!"

40. What are Trochilidae?

ANS.—Humming-birds. They are birds of the smallest size and of the most gorgeous plumage to be found in the feathered race. About 400 species are recognized, yet only one, the *Ruby-throated*, visits the North Atlantic States,



and but ten, any part of the United States. Their food consists of insects and honey, which are secured by extending the tongue into flowers without opening the bill very wide.

41. Which bird has a bill almost as long as its body?

Ans.—The Toucan (*Rhamphastidae*). The bill is light, being cellular in its structure, and is serrated on its edges. The *Ivory-billed Woodpecker* is the largest north of Central America. With its wedge-shaped bill it can bore a hole three feet deep for its nest in the trunk of a living tree.

42. Name the families of the Raptores.

Ans.—The Strigidae (Owl) Falconidae (Hawk) and Cathartidae (Vulture). Among all the rapacious birds, none are more remarkable in their appearance than the Owls. These birds have a comparatively short body, very loose plumage, very large head, very large eyes directed forward, a curved bill nearly concealed by bristle-like feathers, and large ear cavities; and the whole expression of the face is decidedly cat-like. This extensive family is cosmopolitan, several species being circumpolar, and at least two existing all over the world, unless Australia be an exception. The tremulous and doleful notes of the little Mottled or Screech Owl, the prolonged and painful cry of the Long-eared Owl, the grating noise of the little Acadian or Saw-whet Owl, are sounds most unwelcome to him who has not yet learned the harmless nature of the beings from which they come.

43. Which are the scavengers among birds?

Ans.—The Vultures. To this family belong the Cali

fornia Vulture, the Black Vulture, the Turkey Buzzard, and the Condor of the Andes. They are the most numerous in warm countries, where they serve a most important purpose in removing dead and decaying animals. They are generally inoffensive, seldom capturing their food unless forced to do so by hunger.

#### 44. What is the meaning of Columbæ?

ANS.—The name is derived from the Latin *columba*, a pigeon. The Wild or Passenger Pigeon, of North America, is seventeen inches long, and has the upper parts blue, under parts mainly purplish-red, and the sides and back of the neck a glossy golden-violet. This Pigeon is extremely rapid in flight, being able to perform a long journey at an average speed of a mile a minute! The migrations are for the purpose of procuring food (?), and hence do not take place at any particular season of the year. Millions of pigeons often associate in a single roost, completely filling a forest for thirty or forty miles in length and several miles in breadth, and literally loading and breaking down large trees. Sometimes in their migrations they fill the air like a cloud, and thus continue to pass for a whole day, or even for two or three successive days.

#### 45. What is the difference between the Quail and the Partridge?

ANS.—In New England the *Perdidae* (Partridges) are called Quails. The true quail is found in the Old World, and is migratory in habit, leaving Africa in the spring, and returning from Europe in the autumn. The Ruffed Grouse is called *partridge* in New England and the West, and *pheasant* in the Middle and Southern States.

## 46. Name the "short-winged" birds.

Ans.—The Ostrich and the Apteryx. The former is the largest living bird. It will run thirty miles an hour, and is captured by the Arabs on their fleet steeds only after a chase of a day or two, by several relays of horses and riders, and by pursuing in a straight line while the bird runs in a curve. Its feet are two-toed, and the outer toe is destitute of a nail. Its eggs weigh about three pounds each. The South American Ostrich or Rhea, is much smaller and has three toes, each provided with a nail.

Query.—Have you read about the Ostrich farms of Cape Colony? What bird has no tail? How is the plumage of birds rendered waterproof? How often do birds moult their feathers? For what is the mocking bird remarkable? At what rate do swallows fly? What is the technical name of the Chickadee? Where is the parrot found in the United States?

47. What are Grallatores (*waders*)?

Ans.—The old name for the three orders of Limicolae, Heriodiones, and Alektorides. The Oyster-catchers have the bill acute in one genera, truncate in another, and in all cases hard, and the legs short and brightly colored. Those with a truncate bill pry open the shells of bivalve mollusks to eat the animal; those with an acute bill turn over pebbles in search of food. The most common species is about eight inches long.

## 48. What is said of the White Stork?

Ans.—It is exceedingly useful, feeding upon garbage and noxious creatures. A tame stork has been known to join children playing hide and seek, run when touched, and to distinguish the child whose turn it was to pursue the rest so well as to be on its guard along with the others.

The Germans and Dutch esteem it a good omen when a stork builds its coarse nest of sticks on their house-top, Innumerable stories are current among different nations ascribing to the stork, gratitude, chastity, parental affection, conjugal fidelity and filial piety. In the Tyrol, for example, a male stork refused to migrate, and passed several winters with his mate, which, being wounded, could not fly.

49. What was the sacred bird of the Egyptians?

ANS.—The Ibis, probably because it rid them of serpents, the skins and scales of which have been found in the Ibis mummies. Some think, however, that the reason of this worship was merely because the coming of the bird was simultaneous with the annual overflow of the Nile, and hence symbolical of fertility. Whoever killed an Ibis was mobbed, while the dead bird was embalmed. The Ibis multiplied in consequence to such an extent as to impede travel in the streets. The affection of the bird for Egypt was so great that, according to Acteon, when taken away it died of home-sickness. But now, being killed and eaten by the modern inhabitants, who have abandoned the faith of their fathers, it has almost deserted the country.  
—(*Figuiet.*)

50. From what is the name *Alectorides* derived?

ANS.—From the Greek *alektor*, a cock, and *eidos*, form, alluding to a fancied resemblance. The Rails or Rallidae have a compressed body, rather short bill, very short concave wings, a turned-up tail, large legs, and exceedingly long toes, which enable them to run over soft ground, and

even on the surface of broad floating leaves like those of water-lilies and other aquatic plants. Rails are mostly of small size, varying from five or six inches to eight inches in length. The Clapper Rail or Marsh Hen, however, is sixteen inches long.

51. How are Flamingoes distinguished?

ANS.—By their very long neck and long legs, and their large bill which is abruptly bent downward in the middle. Its plumage is a deep scarlet on the back, and roseate on the wings. Its tongue is very fleshy, and, during the days of Rome's extravagance, her gluttons were wont to parade a dish composed of flamingoes' tongues.

52. How are "foot-covered" birds recognized?

ANS.—By the totipalmate foot, that is furnished with three full webs. In all these, the hind toe is low down and more or less turned to one side, and is connected with the inner toe by a complete web. The birds of this order (*steganopodes*) are hatched in a feeble condition, and require feeding by the parents.

NOTE.—The *Brown Pelican* flies ten to twenty feet above the surface, watching the shoals of fish beneath, till a chance offers, when it falls flatwise, often with a force that would be fatal to itself if it were not for a thick layer of air-cells just beneath the skin, which breaks the force of the blow. Scooping up one or more with its pouch, it rises, repeating the operation as often as the capacity of its pocket will permit.

53. Name the "long-winged" birds.

ANS.—Gulls, Petrels, Terns, Albatrosses, Skuæ, etc. The Terns have a long, slender and acute bill, with man-



dibles of nearly equal length, the wings extremely long and pointed, the tail generally forked and the feet very small. They are much more beautiful in their form and more graceful in their movements than the Gulls, and are often called Sea Swallows. In the Scissors-bill the lower mandible, with the shape and sharpness of a knife-blade, shuts into the grooved edge of the short upper one like a razor into its handle.

54. Which is the best "swimmer" among birds?

Ans.—The Loon. It gleans its scanty pittance from the whirling surges of the sea, and as it makes its appearance in great numbers just before a storm, seeking food and shelter in the wake of the vessel, it has been charged with creating the tempest. Its flesh contains much oil, and the natives of the Faroe islands are said to make a lamp by drawing a wick through the body of a very fat one, and lighting the end which projects from the beak.

55. What animal is half bird and half fish?

Ans.—The Penguin. They cannot fly, as their wings are hardly more than mere flippers or paddles, covered with scale-like feathers, and their bones are solid and heavy. They are confined to the cold regions of the Southern hemisphere—in Patagonia, where they are said to collect in such numbers at breeding places as to cover thirty or forty acres—and rarely go on shore except to lay their eggs. Some species, however, carry them about in a sort of pouch on the abdomen.

Query.—Where are fossil remains of birds to be found? What forms the "wish-bone" of birds? What was the Dodo? Describe the Goosander. How long do swans live? What bird pursues its

prey under water? What are Mergansers? What bird is called by sailors, Mother Carey's Chicken? Which is the largest sea-bird? Which one of the Pygopodes has become extinct?

NOTE.—The Kiwi Kiwi (*Apteryx*), or the bird without wings, is found only in New Zealand. It is extremely fleet of foot, and hard to capture. As it lives in the swamps, and hides in the daytime, only coming forth at night, the natives have almost given up the effort to obtain it, and it is only for their chiefs that they ever pursue them. The chiefs alone are permitted to wear cloaks made of its skin, and the owner of a Kiwi cloak is a very proud man.

### 56. Name the orders of Reptilia.

ANS.—*Testudinata*, (Tortoise); *Loricata*, (Alligator); *Lacertilia*, (Lizard); *Ophidia*, (Snake). The blood of Reptiles is never completely oxygenated; to a certain extent it is always impure, and hence their temperature is correspondingly low, and their habits are generally sluggish. In warm countries, however, some kinds—as Lizards—are very active. They are generally carnivorous, and swallow their prey whole.

### 57. Describe the River Tortoise.

ANS.—It is a common North American species whose sharp-edged jaws are strong enough to bite asunder a stick half an inch in diameter. It is fond of water-fowl, swimming beneath the surface and quietly dragging them under. About June 10th, in the temperate climates, it lays thirty to fifty spherical eggs. For their reception, a hole is scooped in the sand by the hind feet, and then smoothed over and left. This entire work is done within fifteen or twenty minutes. The eggs are hatched by the heat of the sun in about three months, when the young immediately take to the water.

## 58. What is said of Sea Turtles?

Ans.—In the Antilles and other breeding-places the turtle is exceedingly valuable. Its eggs are a delicacy; its flesh is used for food: its fat for oil and butter; its carapace for drinking troughs, bathing tubs, canoes, roofs to the native huts, and the tortoise shell is an article of commerce.

NOTE.—There is a family of sea-turtles called the Sphargididæ or Leather-back Turtles, whose general form is something like that of a flattened pyramid, and whose body is covered with a thick coriaceous skin instead of a hard shell. They inhabit the Atlantic and Mediterranean, and are the largest of all turtles, attaining a weight of twelve hundred to two thousand pounds.

## 59. What do the Saurians include?

Ans.—The huge fossil Dinosaurs, the Crocodiles, the Lizards, the fossil Ichthyosaurs, etc., the Pterodactyls, etc. Many of the bird-like tracks of the Connecticut valley are regarded as those of huge dinosaurs. They are also found at various places, from the northern portion of Massachusetts to Long Island Sound. The Dinosaurs are an order of reptiles which we know only by their fossil remains.

## 60. Explain the difference between the Crocodile and the Alligator.

Ans.—The Crocodiles belong to the Nile and Ganges; the Alligators to the Mississippi and waters of Florida. The former attain the length of thirty feet; the latter fifteen feet or more. By a peculiar arrangement, the Crocodile can instantly close the entrance to its throat, so as to prevent the ingress of water, and thus, by bringing from time to time the extremity of its snout above the surface, it can with impunity maintain its grip upon the prey and keep it under water.

NOTE.—*Crocodiles* have the long “canine” teeth so arranged as to fit into holes in the upper jaw, the hind feet webbed nearly to the toes, and a ridge of projecting scales down the outer border of their hind legs. *Alligators* have the “canine” teeth arranged to fit into a pit in the upper jaw, and they have no ridge of projecting scales on the outer border of their hind legs, and their hind feet are not so completely webbed as those of the *Crocodiles*.

### 61. Can the Chameleon change its color?

ANS.—Many of the stories current about the chameleon’s change of color are doubtless fabulous; yet it can become at pleasure yellow, green, or black. “In the skin there is a network of minute ducts, connecting with pigment-vesicles on the under surface, which contain the coloring liquid. The tint of the animal depends on the amount of this liquid injected into the ducts.”—(*Bert.*) The process seems somewhat analogous to that of blushing in the human species.

NOTE.—Reptiles continue to live and exhibit movements long after losing the brain, and even after the head is cut off. The muscles preserve their irritability for a considerable time after being severed from the body; and even the heart pulsates for hours after it is removed, nor does its loss prevent the animal from moving about. The eyes of reptiles resemble those of birds. Some have three eyelids; others, as serpents, have none, and hence their fixed and staring look.

### 62. What are Glass-snakes?

ANS.—*Lacertilians* which are snake-like in appearance, having no external locomotive members. When frightened, it contracts its muscles so violently that its tail will break off as if it were brittle.

### 63. Have serpents teeth?

ANS.—Yes, and they are pointed, smooth, and arched towards the throat. Most of the venomous ones have,

however, in place of teeth in the upper jaw, two fangs, through which the poison is ejected to the bottom of the wound. The bones of the jaws and mouth are connected by extensible ligaments only, an arrangement by which the mouth may be distended so as to receive an object of much greater diameter than the serpent itself. Snakes shed their epidermis once, and, in many cases, three or four times a year. It parts around the mouth, and the reptile slides out of it by crawling through a crevice to hold it, reversing the cuticle. The *slough* is perfect, even to the epidermis of the eyes.

#### 64. How do snakes bite?

Ans.—Rattlesnakes and their allies, Copperheads, Moccasins, etc., are armed with sharp-pointed, movable poison fangs. These fangs are concealed in a fold of the gum, or raised, at the will of the animal. They connect with a gland situated near the eye, which furnishes the fluid poison. When the snake bites, the fangs are raised, and the pressure of the temporal muscles upon the gland forces the poison along the fang into the wound.

#### 65. What are “rattles”?

Ans.—Rattlesnakes have on the end of the tail a series of horny enlargements, loosely attached to each other, which, when shaken, make a rattling noise. Each slough leaves a new button, while the end ones are drooping off from wear; hence the number is no indication of age.

*Query.*—What is the difference between a tortoise and a turtle? Where is the Bearded Tortoise found? What are Thecodonts? Have reptiles ears? What are the largest serpents known? What is the only known remedy for a snake bite? *Ans.* Intoxication superinduced by some form of alcoholic drink. What are Hydrophidæ?



**NOTE.**—In India and Africa there are poisonous snakes known as Vipers, which can raise up and draw forward the anterior ribs so as to dilate the forward part of the body into a more or less broad disk. The Spectacled Viper or Cobra of India is one of these vipers which has a black line resembling in outline a pair of spectacles traced on the widened portion of its disk. This is the snake whose fangs the jugglers of India extract, and then train it to dance. The Asp of Egypt is a viper not less noted. The ancient Egyptians made it the emblem of the protecting divinity of the world, and sculptured it on the sides of a globe upon the gates of their temples. By pressing this snake on the nape, the jugglers of Egypt threw it into a stiffened, immovable condition, which they called turning it into a rod. It is probably the Asp of Egypt, and the Asp of Cleopatra.

66. Name the orders of Batrachians (*Amphibia*.)

**ANS.**—First, the *Anoura*, tailless animals represented by Frogs, which lay their eggs in large masses in ponds; Toads, which lay them in long strings, also in ponds, skin more or less warty; Tree-Toads, which have the ends of the toes in disks, which help them in climbing, and often lay their eggs on trees over water. To the second order *Urodela*, belong the Salamander and Newt. The first-named exudes a milky, glutinous kind of perspiration. By its evaporation this will for a time protect the body from heat, and hence the popular superstition that the animal is fire proof. Of the third order *Amphipneusta* are the Sireus, Proteus, and Axototl.

67. What rank lowest among vertebrates?

**ANS.**—Fishes (*pisces*). “They fall far behind the rest in strength, intelligence and sensibility. The eyes, though large, are almost immovable, bathed by no tears, and protected by no lids. Dwelling in the realm of silence, ears are little needed, and such as they have are without exter-

nal parts, the sound being obliged to pass through the cranium. Taste and smell are blunted and touch is nearly confined to the lips. Destitute of the means of social intercourse (being almost mute), their chief enjoyment is to eat, and to be eaten is the end of their existence. But the class yields to no other in the number and variety of its forms. It includes nearly one-half of all the vertebrate species."

### 68. Into how many orders are fishes divided?

ANS.—Six. The Dipnoi represented by one single family, the singular *mud-fish* of tropical rivers. The Elasmobranchii containing the Rays, Saw-fish, Sharks. The Ganoidei which includes the Sturgeon and Garpike. The Teleostei bony fishes comprising eighteen divisions. The Marsipobranchii (pouch-gilled); and the Pharyngobranchii (gullet-gilled).

NOTE.—Some kinds of spine-finned fishes are beautiful in form; others, as for example, the Toad-fishes and Fishing-frogs, or Lophidæ, of the ocean, are exceedingly ugly. The famous Archers (*chaetodonts*) of the East Indies are spine-finned fishes which have the remarkable habit of spirting drops of water so as to hit and bring down insects which they see above them.

### 69. Describe the Articulates.

ANS.—These *jointed* beings constitute more than four-fifths of the Animal Kingdom. They are divided transversely into rings or joints more or less movable upon one another, and have no internal skeleton. The three classes are the *Insecta—air-breathing* articulates, with the body generally more or less divided into three parts, head, thorax and abdomen, legs jointed. *Crustacea—gill-breathing* articulates, with *head and thorax united* into one part, *distinct from abdomen*, covered with a hard crust, legs

jointed. *Vermes*—gill-breathing articulates, with no distinction of head, thorax or abdomen; legs *not* jointed. The class *Insecta* is divided into the sub-classes of *Insecta proper* (flies, etc.), *Myriapoda* (centipedes, etc.) and *Arachnida* (spiders, etc.), each containing several orders.

70. What is Metamorphosis?

ANS.—The young insect passes through a series of changes before reaching the form of the adult. Thus, a moth, on emerging from the egg, appears as a *larva*; if with legs, a *caterpillar*; if without, a *grub* or *maggot*. Its whole business now is to eat, and hence in this stage it is most injurious to vegetation. After repeated molts, to allow for the enlargement of its body, it usually rolls itself into a cocoon and becomes a *pupa*, during which stage it remains quiet. At length, the time varying with different species, it bursts forth an *imago*. It is now furnished with wings, and the two sexes pairing, eggs for the next generation are laid, and the parents die.

71. What are the sorts of *Apidae* (*Honey-bees*)?

ANS.—Females or *queens*, males or *drones*, and imperfectly developed females or *workers*. In each swarm is one queen, which lays the eggs in three broods: the first producing workers; the second, drones; and the third, queens. The drones are the idlers, and are killed by the workers after the pairing season.

72. What are *Ichneumons*?

ANS.—Animals whose mission is to prevent the increase of other insects. They deposit their eggs in the eggs, larvæ, and pupæ of other insects; and upon these the *ichneumon* larva feeds when hatched.

NOTE.—One of the most noted species of the Lepidoptera is the *Death's-head Moth*, so called because on the back of its thorax there is a rough figure of a human skull, and it emits a plaintive squeal when disturbed.

73. What insect is provided with a *piercer*?

Ans.—The female Cicadas (*Harvest-fly or Locust*) with which they perforate the limbs of trees, in which they lay their eggs. This piercer consists of three pieces; two outer ones, which are grooved on the inside, and toothed on the outside like a saw, and a central piece, which is a sort of spear-pointed borer, which moves freely between the other two. The Greeks, we are told, often kept these insects in cages that they might enjoy their “music!” And the Greeks also used them as food, eating both the pupæ and the perfect cicadas.

74. What are wingless Dipters?

Ans.—Fleas which are noted for their strength and docility. The “learned fleas,” exhibited in Paris, a few years ago, went through military evolutions, standing on their hind legs and shouldering tiny spears: and two of them drew a companion in a little wagon, a fourth sitting on the coachman's box and wielding the whip. The spectators viewed this wonderful exhibition through magnifying glasses.

NOTE.—The Earwig (Ear-wing) sits upon its eggs till they are hatched, and then broods its young as a hen does its chickens.

75. Describe the Hair-snake.

Ans.—It is so called from the erroneous notion that it originates from horse-hairs soaked in water. Probably, by the eggs being eaten, the larvæ obtain access to the bodies of grasshoppers, etc., and, coiling up within the cavity,



reach a length often ten-fold that of their host. At maturity they desert the insects at whose expense they have been nourished, and seek the water to lay their eggs and die.

76. What are Mollusks?

ANS.—Those animals which have a soft body, enveloped by a muscular skin called a mantle, and in most cases protected by a shell; they are not jointed nor radiated in their internal structure. The shells are the parts of these animals which we oftenest see; for when the animal is dead the soft parts soon disappear, and only the shell remains. Most kinds of mollusks increase by means of eggs: some kinds are viviparous, and some kinds of tunicate mollusks increase by budding. Their blood is white or colorless.

77. What are the characteristics of the Cephalopoda?

ANS.—They have muscular tentacles or arms around the mouth; beaked, horny jaws; two large eyes; arms covered with sucking disks; and a bag of ink, with which most species blacken the water to hide from pursuit. To this class belong the "sailors"; the cuttle-fish, which has a spongy, calcareous-mass within its body, known as cuttle-fish bone, and used for canary birds; the beautiful nautilus; and the famous devil-fish.

78. What is said of the Muricidæ (rock-shells)?

ANS.—The *Murex* has the aperture of its shell prolonged into a canal. The Shetlanders use this shell for a lamp, inserting the wick in the canal, and filling the body of the shell with oil. From these mollusks the ancients



obtained the costly Syrian dye, the "purple" of Scripture.

79. Why do shells give a murmuring noise when held to the ear?

ANS.—The usual explanation of the "roar of the sea" in shells is that the form of the shell and its polished surface collect and reflect sounds in the air, otherwise imperceptible. Another theory refers the murmur to the circulation of the blood through the capillaries of the fingers holding the shell by which vibrations are magnified. A feeble murmur can be heard, however, when the shell rests on a table, and it is probable that both causes are concerned in the phenomenon.

80. What is the meaning of Echinoderms?

ANS.—Spiny-skinned. They are radiate animals which have a tough skin containing particles of carbonate of lime, or a shell composed of calcareous pieces, which are movable, or fixed together, and covered with tubercles or spines. This sub-kingdom is divided into the four classes of Holothurioidea (*sea-cucumbers*) Echinoidea (*sea-urchins*), Asteroidea (*star-fishes*) and Crinoidea (*feather-stars*).

81. What are the Coelenterates?

ANS.—Radiates having a distinct body-cavity, whose walls consist of an outer layer (*ectoderm*) and an inner layer (*endoderm*). They are all aquatic, and multiply alike by budding, by eggs and by fission. They are usually armed with peculiar stinging filaments. There are the four classes of Ctenophora (*comb-bearers*); Anthoza (*flower-like animals*); Hydrozoa (*water-dragon animals*)—such as Jelly-fishes and the Portuguese Man-of-War; and Spongida (*sponges*).

NOTE.—The Medusæ, Nettles, or Jelly-fish, are the terror of bathers, as the pain inflicted by the lash of their envenomed filaments is exceedingly deranging to the whole nervous system, though at first seeming to be no more than the tingling sensation of the common stinging nettle.

### 82. Describe the Protozoans.

ANS.—They are small, living mostly in the water, and many are microscopic. They are composed of a mucous, albuminous substance called *protoplasm*. They have no distinct organs of circulation or digestion, possess neither nerves nor muscles, although they take food, grow and multiply, and many are exceedingly active. Innumerable invertebrates feed upon them.

### 83. Name the classes.

ANS.—The Infusoria, (including the *vorticels* and *noctilucae*); the Rhizopoda (*root footed*), and the Gregarinida (*flocks*), which are parasitic forms found particularly in Cockroaches and Earthworms. *Bathybius*, of the Monera, a mass of albuminous jelly, neither distinctively animal or plant, is considered the simplest structure known to man.

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### At Your Leisure.

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What monkey furnishes us with an example of a synthetic or *comprehensive* type? Give examples of the Phocidæ and Ursidæ. What are Bovidæ? What are the differences between Carnivorous and Herbivorous animals? Where is the Yak, or grunting ox, to be found? Upon what do deer live? What comparison can be drawn between the Peccary and Wild Boar? What animal is supposed to be the “cony” of Scripture? Explain the

difference between the Asiatic and African elephants. What is the "Puffing Pig"? What is a Vampire? Is there really a flying squirrel? Does the porcupine throw his quills? In what country are singing mice to be obtained? What is the name of the female Fox? Ans. Vixen. Give comparative description of a cat and a goose, stating likenesses and differences. Why were the Armadillos so called? *Marsupium* means what? What are the Didelphididæ? What are *granulations* in birds? *scutella*? What temperature is needed in hatching eggs? Mention the habits of the Cow-bird, Baltimore Oriole, and Bobolink. What bird has a gape with bristles? What bird is the chosen symbol of our country? For what is the Man-of-War Bird remarkable? What birds are used by the Chinese for fishing? Give examples of digitigrade and plantigrade animals. To what general class does the whale belong? What are the "butchers" of the sea? Which fish gives a violent electric shock? What are the "stone-suckers"? Of what country is the Gold-fish a native? What fish has four beards hanging from the mouth? What is the technical name of the "sleeper-out"? What becomes of a hive without a queen? Give some account of the bee communities. What is Entomology? How many *facets* has the common house-fly? Mention and describe some insects which are destructive to crops. How are the male Humble-bees distinguished? Ans. By their *white* faces. What animal lays 80,000 eggs in a day? How do the Seventeen-year locusts derive their name? What insect produces caterpillars? What are *Wiggle-tails*? How are the notes of the Katydid produced? What is the antidote for a serpent's bite? Name some of the Crustaceans. What are Vermes? What does the *Trichina* inhabit? In what mollusks are the sexes united? What is a "siphuncle"? Describe the Hammer Oyster. Are there *red* canary birds? What is your idea of the rel-

ative importance of the subject of zoölogy, and of the place it should occupy in the school course? Name the classes of the Hymenoptera order. What is the meaning of Aphidæ? (While reptiles can live in air too impure for mammals, birds will die in an atmosphere which to mammals is quite harmless.) What animal can leap two hundred times its own height? Ans. A flea.









# CHEMISTRY.



# CHEMISTRY.

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## 1. Chemistry is what?

Ans.—Chemistry is that branch of science which treats of the composition of bodies, or of the changes which take place in matter whereby it loses its identity. Organic chemistry deals with those substances which have been produced by life; as *flesh* and *wood*. Inorganic chemistry is confined to those which have not been formed by life; as *glass* and *metals*.

NOTE.—Of the sixty-four elements now known, fifty-one are to be considered as metals and the remaining thirteen non-metals. *Vide Philosophy.*

## 2. What causes favor chemical action?

Ans.—Heat and light; and solution aids in chemical change, as it destroys cohesion and leaves the atoms free to unite.

## 3. What is Synthesis?

Ans.—The putting of substances together to form chemical compounds; it may occur with different degrees of energy. It takes place: 1. In constant proportions between the same elements. 2. In multiple proportions between the same elements. 3. In constant or multiple proportions for all elements.

NOTE.—The compounds formed are *binary*, *ternary* or *double*. They may be formed: 1. By the simple bringing together of substances under conditions favorable to chemical action. 2. By the substitution of one substance for another in a given compound (substitution). 3. By interchanging of substances in two given compounds (metathesis or double substitution).

#### 4. What is Analysis?

ANS.—The separation of compounds into their constituent parts; it may be Qualitative, showing only the elements contained, or Quantitative, showing the amounts of each element contained.

#### 5. How is the nomenclature of chemistry derived?

ANS.—Many of the long known substances retain their old names, as iron, gold, silver, lead, sulphur, etc., but in *symbolizing*, the initials of the Latin names are used, as Fe, ferrum; Au, aurum; Ag, argentum, etc. The more recently discovered metals have generally received names ending in *um* and so called from some peculiar property, or from the name of the compound substance from which they were separated; as sodium, potassium, etc. Names of compound substances are formed by combining according to certain rules the names of the simple elements composing them; as hydrogen sulphide. Certain non-metallic elements having some resemblance have received names with similar terminations, as bromine (named from its bad odor), chlorine (named from its green color), iodine (named from its beautiful violet-colored vapor), etc.

#### 6. Describe the Symbols.

ANS.—For convenience, chemists use symbols to represent the simple elements. This symbolism is very simple,



consisting of the initial letter or letters of the name of the element. Where more than one element begins with the same letter or letters, the second or third letter is also used. Compounds are indicated by writing the symbols of their elements in close connection. C is the symbol for carbon, but as chlorine begins with the same letter Cl is used for that element. Cu for copper from the Latin name *cuprum*, and  $H_2O$  is the symbol for the element, water. When a symbol stands without any figures attached, as H, it means an atom of that element. When a small figure is written below, it means that a corresponding number of atoms is taken.  $H_2$  means two atoms of hydrogen.  $H_2O$  means two atoms of hydrogen and one of oxygen.

### 7. What is an Oxide?

ANS.—One atom of O in a molecule forms the monoxide or protoxide, two the dioxide or binoxide, three of O and two of the other element the sesquioxide (meaning  $1\frac{1}{2}$ ), and the highest number, the peroxide.

### 8. Define Acids, Bases, and Salts.

ANS.—There are two large classes of oxides chemically opposed to each other, termed *acids* and *bases*; their compounds are called salts. The acids are generally sour and turn vegetable colors—such as the infusion of blue litmus, or of purple cabbage—to a bright red. They are named from the elements with which O combines. The termination *ic* is given to the positive element when it has the greater proportion, and *ous* when it has the lesser proportion as *sulphuric*, the stronger, and *sulphurous*, the weaker. When the proportion is still less than *ous* it takes the prefix *hypo* as hypochlorous acid; when greater than *ic* it takes the prefix *per*, as perchloric oxide. The bases are com-

monly oxides of the metals. Their termination, as in the acids, indicates the amount of oxygen. In naming a salt, the termination of the acid is changed—an *ic* acid forming an *ate* compound, and an *ous* acid an *ite* compound. Thus the salts of nitric acid are called nitrates, and of nitrous acid, nitrites.

NOTE.—The compounds resulting from oxygen uniting with most metals are called *oxides*. Really they are ashes, but are commonly known as rust. Gold, silver, platinum, and mercury are called noble metals, because they do not easily rust, but retain their brightness. Hot metals rust more easily than cold.

Query.—What are atoms and molecules? What is meant by atomic weight? What are proximate and ultimate elements? Substances may be what? How may decomposition be produced? What is meant by Electrolysis? (Vide No. 1 Dime Series). What does the study of chemistry comprise? Express a compound molecule.

## 9. What is a formula?

ANS.—An algebraic statement of the symbols and relations of several compounds. The sign  $+$  indicates a feeble attraction or a mere mixture. The sign  $=$  indicates conversion into. The comma or the period denotes a combination. The brackets and co-efficients are used as in algebra.

NOTE.—An analysis of water shows it to be composed of 88.89 parts of oxygen and 11.11 parts of hydrogen by weight, which is as 8 to 1. By volume it is composed of two parts hydrogen to one part oxygen. We then say that two atoms of hydrogen are used and that the atomic weight of oxygen is 16 and the formula,  $H_2O$  expresses the proportions of both weight and measure. The molecular weight of water is

$$2+16=18;$$

hence the proportion of H is 2-18 or 1-9, and of O, 16-18 or 8-9. In 10 lbs. of  $H_2O$ , there are therefore

$10 \times 8-9 = 8 \text{ } 8-9$  lbs. of O, and  $10 \times 1-9$  or  $1 \text{ } 1-9$  lbs. of H.

How else may this be solved? Ans. By proportion.

## 10. What is the meaning of Oxygen?

ANS.—*Acid-former*, and was given because it was supposed to be the essential principle of all acids; but hydrogen has since been found to be the true acid-maker. Its symbol is O; atomic weight, 16; specific gravity, 1.1.

NOTE.—To make oxygen gas, take half an ounce of powdered chlorate of potash ( $\text{KClO}_3$ ), and mix it with enough black oxide of manganese ( $\text{MnO}_2$ ) to make it black. Then place the powder in a flask furnished with a perforated cork and long bent tube, placing the flask on a ring of the retort stand so that you can gently heat the mixture, and then collect the gas as it comes over in bottles placed in a pneumatic tub.

## 11. What else is said of oxygen?

ANS.—It is a colorless, invisible, tasteless gas. It exists in the *free state* in the air, mixed with about four times its bulk of nitrogen gas. It also comprises by weight  $\frac{8}{9}$  of the water,  $\frac{2}{3}$  of all animal bodies, and more than  $\frac{1}{2}$  of the crust of the earth. It combines with all the elements (with one exception) to form oxides. When it combines with other elements *heat* is evolved, and often *light*, and the substance is said to *burn*. It is necessary for the life of animals; they breathe it, and use it to oxidize and purify the blood and to keep up the animal heat.

## 12. What is ozone?

ANS.—An allotropic form of O, i. e., a form in which the element itself is so changed as to have new properties. It is always perceived during the working of an electric machine, and is then called "the electric smell." It has also been detected near objects just struck by lightning. Electricity is supposed to have something to do with the formation of the ozone in the atmosphere.

## 13. What are its properties?

ANS.—It is more corrosive than oxygen, bleaches powerfully, and is a rapid disinfectant. A piece of tainted meat plunged into a jar of it is instantly *deodorized*, and it is probable that, even in minute quantities, this gas exercises a powerful influence in purifying the atmosphere.

## 14. Define Atomicity.

ANS.—It is a term used to denote the combining power, or the proportion in which the atoms of elements unite with atoms of hydrogen. The elements are arranged in seven groups and receive the names of monads, dyads, triads, tetrads, pentads, hexads and heptads, according as they unite with 1, 2, 3, 4, 5, 6 or 7 atoms of hydrogen. The elements which have an even atomicity are called *artiads*, those having an odd atomicity are called *perissads*.

## 15. Describe Hydrogen.

ANS.—Like Oxygen it is a colorless, invisible, tasteless gas. It does not exist in the *free state* in the air but combines with oxygen to form water. Hydrogen also combines with many other elements: with carbon it forms marsh-gas (or fire-damp), a substance found in coal-gas; it is found in all acids, and is the lightest substance of which we know, being  $14\frac{1}{2}$  times lighter than air, and it has, therefore, been used for filling balloons.

Query.—What is the meaning of hydrogen? Define chemical affinity. When was the termination *uret* used instead of *ide*, and what did it mean? Name an acid that is not sour. What are the alkalies? What is the "water-type"? What is an *anhydride*? What is antozone? Define the terms *equivalence* and *quantivalence*.

## 16. How can we get hydrogen from water?

ANS.—In several ways. Throw a small pellet of potas-



sium, as large as half a pea, upon the surface of water contained in a basin. The metal, being lighter than water, swims on the surface, but the moment it touches the water a flame arises around the metal. This flame is caused by the hydrogen of the water, which is set free and takes fire and burns. The oxygen unites chemically with the metal potassium to form the alkali potash.

*Experiment.*—Mix hydrogen and chlorine gases in the dark and as soon as the bottle containing them is taken into the sunlight, an explosion follows, from the combination of the two gases; a new substance, hydrochloric acid gas is formed.

### 17. Why is Nitrogen so called?

Ans.—Because it exists in nitre. Like O and H it is transparent, colorless, and odorless. It exists in the *free state* in the air. We can separate the oxygen in the air from the nitrogen by burning a piece of phosphorus. N is found in many compounds, in nitric acid and nitre or saltpetre, and in ammonia or spirits of hartshorn. It is also found combined in the flesh of animals. N does not unite readily with bodies, and is a very inert substance; it does not burn itself, nor support combustion nor animal life. It is, however, not poisonous, and animals die when placed in it simply from want of oxygen, that is, they are suffocated.

### 18. What is meant by the Nascent State?

Ans.—At the time when heat, electricity or any other force has just separated the atoms of which a body is composed, those atoms are said to be in the “nascent state” and possess unusual attractive power. Many gases, which do not ordinarily show any affinity for each other, will unite if they are brought near together at the moment they are produced. Thus N and H at the very instant of their separation will combine and form  $H_2N$ .



*Experiment.*—Put half an ounce of powdered nitre into a retort and pour upon it half an ounce of sulphuric acid. Then put a lamp under the retort, and a flask, kept cool in a basin of water, to catch the acid which comes over. Soon a liquid will collect in the flask. This is nitric acid.

### 19. What is Carbon?

**Ans.**—A solid element and one of the most abundant substances in nature, forming nearly one-half of the entire vegetable kingdom. It exists in three distinct forms as *diamond*, *graphite*, and *amorphous carbon*. This last term includes charcoal, coke, soot, bone black, etc. Proof is given that these three forms contain carbon and nothing else, by taking the same weight of each and by burning them separately, when we obtain exactly the same weight of carbonic acid.

**NOTE.**—The diamond is pure carbon crystallized, but it has never been made by any chemical process. Minute diamonds, it is said, have been separated from carbon compounds by long-continued voltaic action, but they were invisible except with a microscope. The value of the diamond varies with the market; the general rule is as follows: a gem ready for setting, of one *carat* weight, is worth \$150 to \$180; beyond this size, the estimated value increases according to the square of the weight, but in case of large stones is generally much less than that amount, although rare beauty or size may greatly enhance the price. The *Kohinoor* ("mountain of light", now among the crown jewels of England), weighs 103 carats, yet is valued at \$10,000,000. Owing to the discovery of many large diamonds in South Africa, the value of such stones has much decreased of late. The smaller ones, however, are becoming more expensive on account of the greater demand for them. The South African diamonds are seldom colorless, having generally a yellowish tint. Paste diamonds are now made in Paris, which are so perfect an imitation that only experts can distinguish them from the real gems.

### 20. How is charcoal made?

**Ans.**—By burning piles of wood, so covered over with

turf as to prevent free access of air. The volatile gases, water, etc., are driven off, and the C left behind. This forms about  $\frac{2}{3}$  of the bulk of the wood and  $\frac{1}{2}$  its weight.

21. Why does wetting half-burned coal increase its combustion?

Ans.—Coal, as well as wood, consists of C, H, and O; but while in wood the proportion of H and O to C is about fifty per cent., in the different kinds of coal the proportion of the gases to the carbon varies from only five per cent. in anthracite to eighteen per cent. in bituminous coal. When coal is burnt, not only does the oxygen of the air unite with its carbon to form carbonic acid gas ( $\text{CO}_2$ ), but the heat of the kindling develops into gas the oxygen in the coal itself, which, being in the nascent state, has special activity in uniting with the carbon and greatly assists the combustion. Half-burned coal does not take fire readily, because the gases within it have been expelled by the previous burning. Now water ordinarily puts out fire by cooling it below the point of ignition, but when coal is merely dampened with it, the heat of the burning kindling is sufficient to convert the film of water not merely into cooling vapor but into its constituent gases H and O. The O thus developed, being in the nascent state unites actively with the C, thus taking the place of the oxygen in the coal which was expelled by the previous burning.

Query.—When are the molecules of a body said to be *amorphous*? What is the meaning of *dimorphous* and *isomorphous*? How much S is there in 4 lbs. of  $\text{H}_2\text{SO}_4$  (sulphuric acid)? Describe the Philosopher's Lamp. Has water an atmosphere? What are the uses of water? From what is the term *carat* derived? Describe the process of making a lead pencil. What is graphite?

22. What is Peat?

Ans.—An accumulation of half decomposed vegetable matter in swampy places. One-tenth of Ireland is covered with peat-beds. Produced mainly by a kind of moss it undergoes gradual changes, and becomes a brownish black substance, loose and friable in its texture, resembling coal, but, unlike it, containing 20 to 30 per cent. of O. After being cut out in square blocks and dried in the sun, it is used as fuel. Muck is an impure kind of peat, not so thoroughly carbonized.

### 23. What is Fire?

Ans.—It is the heat given off when bodies burn or combine chemically. Combustion, *in general*, is the rapid union of a substance with O, and is accompanied by heat and light. Our fuel and lights, such as wood, coal, oil, tallow, etc., consist mainly of C and H, and are, therefore, called hydrocarbons. In burning they unite with the O of the air, forming  $H_2O$  and  $CO_2$ . These both pass off, the one as a vapor, the other as a gas. So from a burnt candle we have remaining carbonic acid gas and water.

### 24. How are explosions in coal pits prevented?

Ans.—By using Davy's Safety Lamp. By holding a fine wire-gauze over the flame of a candle or lamp the flame is prevented from passing through because the metallic gauze conducts away the heat and thus reduces the temperature below the igniting point. Some miners use an ordinary oil-lamp, surrounded by a cylinder of fine wire-gauze.

### 25. What is spontaneous combustion?

Ans.—The result of chemical changes taking place in combustible substances, whereby heat enough is generated to cause ignition. CaO occasionally absorbs  $H_2O$ , so as to

set fire to wood in contact with it. The waste cotton used in mills for wiping oil from the machinery, when thrown into large heaps, often absorbs O from the air so rapidly that it bursts into a blaze.

## 26. Describe the atmosphere.

ANS.—The “air we breathe” consists of N, O,  $\text{CO}_2$ , and watery vapor. The first composes  $\frac{4}{5}$ , the second  $\frac{1}{5}$ , the third about  $\frac{1}{1000}$ , and the last a variable amount, though N and O form so large a part, that they are considered in ordinary calculation to form the whole atmosphere. A very clear idea of the proportion of these several constituents may be formed by conceiving the air, not as now dense near the surface of the earth, and gradually becoming rarefied as we ascend to its extreme limit of perhaps 500 miles, but of a density throughout equal to that which it now possesses near the earth. The atmosphere would then be about five miles high. The vapor would form a sheet of  $\text{H}_2\text{O}$  over the ground five inches deep, next to this the  $\text{CO}_2$  a layer of thirteen feet, then the O a layer of one mile, and last of all the N one of four miles.

*Experiment.*—Take a bottle open at the bottom and furnished with a neck and a cork at the top. Place the bottle in a basin of water, first floating on the water a little china dish with a small piece of phosphorus (P) the size of a pea in it, and light the phosphorus with a match. The bright flame of P goes out before it is all burnt. Let the bottle stand until it is cool. The white smoke or fumes made by the burning P will disappear leaving a quantity of air; but while the bottle was full of air at the beginning, it now contains considerable water. After removing the cork, a burning taper or match plunged into the gas, at once goes out, proving that there is something different from what was in the bottle at first. O has united with P forming the white fumes and  $\text{H}_2\text{O}$  has taken its place. The gas remaining is N, which extinguishes the burning taper.

## 27. What are the uses of carbonic acid?



Ans.—The leaves of flowers drink in  $\text{CO}_2$  and retaining the C return the O to the air for our use. They exhale O as we breathe out  $\text{CO}_2$ . We pollute the air while they purify it. This interchange of office is so exactly balanced, that the proportion of  $\text{CO}_2$ , and of O, in the open air, never varies.

Query.—Are house-plants injurious to health? What is hay fever? What is meant by *solar force*? What makes hard water? Show the truth of the paradox—“*We live only as we die.*” How is hard chalk water softened? What is asphyxia? What is Soot? When was mineral coal formed?

## 28. Describe the watery vapor.

Ans.— $\text{H}_2\text{O}$  is present everywhere ready to supply the wants of animals and plants. Were the air perfectly dry, our flesh would become shrivelled like a mummy's, and leaves would wither as in an African simoon. All the streams that flow to the ocean are fed by the currents that move in the air above us.

## 29. What is the “Chlorine group”?

Ans.—Chlorine (Cl), Iodine (I), Bromine (Br), and Fluorine (F). They are called haloids or halogens, because they are found in the sea. They are very active, their affinity for O being proportioned to their atomic weights, and for other elements, inversely so. Cl is found in common salt (NaCl) and KCl. It is used for bleaching and as a disinfectant, both alone and in compounds. It has a greenish-yellow color and a peculiarly disagreeable odor. It produces a suffocating cough, which can be relieved by breathing ammonia or ether. HCl is a colorless acid, sp. gr. 1.27, liquefies at 40 atmospheres. One vol.  $\text{H}_2\text{O}$  absorbs 400 vols. OCl. Used in manufacture of soda, “chloride of lime,” and in the laboratory.



NOTE.—Br, prepared from "bittern" of salt water and salt springs, is a dark red liquid of disagreeable odor. Used in photography, medicine, and the arts. F is found most abundantly in fluor spar. It is the only element that will not unite with O. Its acid, HF, is a colorless, volatile and corrosive liquid used for etching glass. I is made from kelp (the ashes of sea-weed), and is deposited in crystals on the sides of the bottle in which it is kept. Its compounds with the metals, called the iodides, are remarkable for their variety and brilliancy of color.

### 30. How can we get Cl from common salt?

ANS.—By mixing a little salt with a little powdered black manganese oxide, putting the mixture into a flask, and pouring upon the mixture some sulphuric acid diluted with the same quantity of  $H_2O$ . By adapting a bent tube and by slightly heating the flask, a heavy, yellow, very strongly smelling gas is given off, and may be collected in a dry bottle.

### 31. What is Boron?

ANS.—An element found in nature in combination with O, as boracic acid. Along the sides of the mountains in the volcanic districts of Tuscany, series of basins are excavated and filled with cold water from the neighboring springs. The jets of steam charged with boracic acid are conducted into these basins. The  $H_2O$  absorbs the acid, and becomes itself heated to the boiling-point. It is then drawn off into the next lower basin and this process is continued until the bottom one is reached, when the solution runs into leaden pans heated by the steam from the earth; here the  $H_2O$  is evaporated, and the acid collected. Borax ( $Na_2O, 2B_2O_3, 10H_2O$ ) is a salt of this acid.

### 32. Of what is Si the symbol?

ANS.—Silicon, which is an element that does not exist

in the free state in nature, although it is contained in enormous quantities in combination with O. Silicon oxide ( $\text{SiO}_2$ ) Silica or Silex is known as *quartz* or rock crystal, and it is found in almost all rocks; as sand, sand-stone, and flint are more or less pure silica. It forms with metals compounds called silicates. It is tasteless, odorless, and colorless. Glass and clay are silicates, so therefore are bricks, pottery and china, which are made from clay. The four varieties of glass are (1), Window or plate; (2), Flint or crystal; (3), Bohemian; and (4), Green bottle-glass.

NOTE.—Glass was known to the ancients. Hieroglyphics, that are older than the sojourn of the Israelites in Egypt, represent glass-blowers at work, much after the fashion of the present. In the ruins of Nineveh, articles of glass, such as vases, bowls, etc., have been discovered. Mummies 3,000 years old are adorned with glass beads. The inventor is not known. Pliny tells us that some merchants, once encamping on the sea-shore, found in the remains of their fire bits of glass, formed from the sand and ashes of the sea-weed by the heat; but this is impossible, as an open fire is not sufficient to melt these materials. In the fourth century B. C., the glass-works at Alexandria produced exquisite ornaments, with raised figures beautifully cut and gilded. But in the twelfth century, A. D., glass was still so costly in England that glass windows were thought to be very magnificent; and, as late even as about 1500, when the great Earl of Northumberland left one of his houses for a time, he was careful to have the glass of the windows taken down and packed for safe keeping.

Query.—How is glass made? In coloring glass what does Co give? As? Cu? What is Prince Rupert's Drop? Why is Borax employed in welding? What place was regarded as the entrance of hell? Why do not stones burn as well as wood? What is annealing?

### 33. Describe Sulphur.

Ans.—S, or brimstone, is a yellow solid element found native in volcanic regions and is mined at Mount *Ætna* in great quantities. It is in the form of fine yellow powder,

flour of sulphur, and in sticks or rolls. If we heat a small portion of sulphur in a spoon over a flame, it first melts, then boils, and then takes fire and burns away entirely, giving off a pale blue flame. It is used for putting on the ends of matches and in the manufacture of gunpowder, which is a mixture of sulphur, charcoal, and nitre.

34. What is the "king of the acids"?

Ans.—Sulphuric Acid ( $H_2SO_4$ ), Oil of Vitriol. It is of the utmost importance to the manufacturer and chemist, as it is used in the preparation of nearly all other acids, and forms many valuable compounds.

35. What name signifies "light-bearer"?

Ans.—Phosphorus. It was called by the old alchemists "the son of Satan." In nature it is similar to Si but is contained in the bones of animals in combination with oxygen and the metal calcium, forming calcium phosphate. When a bone is burnt, a white porous mass is left called bone-ash, and from this, phosphorus can be prepared. P, like C, exists in two different forms: one is known as yellow or common phosphorus; the other as red phosphorus. These two kinds differ very much in their properties.

NOTE.—Prof. Remsen, of Johns Hopkins University, has just discovered a white phosphorus. (Jan. 17th, '83.)

36. What is Hydrogen Phosphide?

Ans.—A poisonous gas, remarkable for its disgusting odor, for igniting spontaneously on coming to the air, and for the singular beauty of the rings formed by its smoke. It has been thought by some that the Will-o'-the-wisp, Jack-o'-the-lantern, etc., as seen near graveyards and in

swampy places, are produced by this gas coming off from decaying substances, and igniting as it reaches the air.

*Experiment.*—Put a piece of P about the size of a grain of wheat on a porous paper and sprinkle over it a little lamp black or dried pulverized charcoal. In a few minutes P will ignite. The C absorbs O from the air. Heat is produced by the condensation and at the same time O is brought in contact with P, resulting in the combination  $P_2O_5$ .

### 37. Describe Arsenic.

Ans.—As is found native, and is chiefly obtained from  $FeAs_2$  and  $FeS_2$ ,  $FeAs_2$ , arsenical pyrites, by roasting: is a brittle steel gray solid of metallic lustre commonly sold when *impure*, as cobalt, though the latter is a reddish-white metal, found in combination with As. It volatilizes at  $180^\circ$  with an odor of garlic; burns with a bluish-white flame and is very poisonous in all its compounds.

NOTE.— $H_3As$ , arseniureted hydrogen, or arsine, is important as affording a means of detecting the presence of As in compounds.  $As_2O_3$ , arsenious anhydride, is a white powder (the arsenic of commerce)—the well-known “ratsbane”—used in the manufacture of glass, and many pigments, and for preserving the skins of animals. As is soluble in hot  $H_2O$ , and has a slightly sweetish taste. It is a powerful poison, doses of two or three grains being fatal, although an overdose sometimes acts as an emetic. It is an antiseptic, and so in cases of poisoning frequently attracts attention by the preservation of parts of the body, even 20 or 30 years after the murder has been committed. The usual antidote for corrosive sublimate, is milk or white of eggs or any ordinary emetic. The exact chemical remedy for arsenic is hydrated ferric oxide.

### 38. Name some of the discoverers of the elements.

Ans.—K, Pt, and Na were discovered by Sir Humphrey Davy in 1807. The next year, he discovered Ba, Ca, Mg, and Sr. Berzelius, in 1817, discovered Se; in 1823 Si; in



1828, Th. Other well-known discoverers are Tennant, Woehler, Wollaston, Klaproth, etc., etc.

### 39. What are the metals of the alkalies?

Ans.—Potassium, Sodium, Lithium, Caesium, Rubidium, and Ammonium, which is a compound radical. Caesium (Cs) and Rubidium (Rb) are only found in small quantities. These metals possess strongly alkaline properties—the power of turning red litmus paper blue, and of neutralizing acids—have a whitish to grayish color, malleable, ductile, and are so soft as to be worked with the fingers.

### 40. What is Kalium?

Ans.—Potassium (K) the metal contained in the alkali potash, and in the potash salts. The latter are found in many places in the earth, and also in the ashes of plants. An acre of wheat producing 25 bushels of grain and 3,000 lbs. of straw, removes about 40 lbs. of potash in the crop. An acre of corn, producing 100 bushels, removes in kernel and stalk 150 lbs. of potash and 80 lbs. of phosphoric acid. An acre of potatoes, yielding 300 bushels, will remove in tubers and tops 400 lbs. of potash and 150 lbs. of phosphoric acid. A pound of wheat holds a quarter of an ounce of mineral substances, and a pound of potatoes one-eighth of an ounce.

Query.—What are Sulphides? Sulphates? Of what is hair-dye made? What is  $H_2S$ ? How is Carbon Disulphide ( $CS_2$ ) produced? What is the story of Prince San Severo? What substance glows in the dark? How are Safety Matches made? What is "fox-fire"? How is  $H_3P$  prepared? What are the results of arsenic eating? What is the antidote for Prussic Acid? Of what is  $K_2O$  the symbol? What is potassium bichromate? What occasions the bad odor of burnt powder? What produces "green stars"?



41. What is  $\text{KNO}_3$ ?

Ans.—Nitrate of Potash, Saltpetre, or Nitre; a salt found as an *efflorescence* on the soil in tropical regions, especially in India. It is obtained thence by *leaching*. It is formed artificially by piling up great heaps of mortar, refuse of sinks, stables, etc. In about three years, these are washed, and each cubic foot of the mixture will furnish four or five ounces of saltpetre.

## 42. Describe Sodium.

Ans.—Na is the metal found principally in common salt. It can not be kept in the air, because it at once oxidizes and forms a white powder; neither can it be allowed to join  $\text{H}_2\text{O}$ , as it will at once combine with O and set free H. Of the soda salts, rock-salt is found in largest quantity: it is obtained from mines in Cheshire, Cracow, Spain and Idaho, and from sea-water by evaporation.

*Experiment.*—To obtain sodium sulphate or Glauber's salts, pour sulphuric acid upon common salt; a dense fume of hydrochloric acid gas comes off, and sodium sulphate is left.

## 43. What is common soda?

Ans.—Bicarbonate of Soda ( $\text{HNa CO}_3$ , or  $\text{Na}_2\text{O} \cdot \text{H}_2\text{O} \cdot 2\text{CO}_2$ ) which is prepared by the action of  $\text{CO}_2$  on sodium carbonate. The  $\text{CO}_2$  may be easily liberated by the action of an acid.

## 44. What compound has never been separated?

Ans.—Ammonium ( $\text{H}_4\text{N}$ ), which acts like a metal, forming salts and amalgams;  $\text{H}_4\text{NHO}$  is common ammonia water;  $\text{H}_4\text{N}$  salts are obtained by distilling nitrogenous bodies. Its chief compounds are  $\text{H}_4\text{NCl}$ , sal ammoniac;  $2\text{H}_4\text{NO}$ ,

$3\text{CO}_2 + 3\text{H}_2\text{O}$ , sal-volatile;  $(\text{H}_4\text{N}) 2\text{SO}_4$ ;  $\text{H}_4\text{N}$ ,  $\text{NO}_3$ ;  $\text{Na}$   
 $\text{H}_4\text{N HPO}_4 + 4\text{H}_2\text{G}$ , microcosmic salt;  $(\text{H}_4\text{N}) 2 \text{S}$ ,  $\text{H}_4\text{N}$   
 Br and  $4\text{H}_4\text{I}$ , used in photography.

45. What are the metals of the alkaline earths?

ANS.—Calcium (Ca), Barium (Ba) and Strontium (Sr)  
 Ca is a metal which is very difficult to obtain in the pure state, although its compounds are very common. Quick-lime is calcium oxide; chalk, marble, limestone, and coral are all calcium carbonate; gypsum is calcium sulphate; and bone earth is calcium phosphate. *Whitewash* is a "milk of lime", or lime diffused through water. *Concrete* is a cement of coarse gravel and water-lime. It is of great durability. *Calcimine* is a variety of whitewash made of whiting or of plaster of Paris.

NOTE.— $\text{H}_2\text{O}$  charged with  $\text{CO}_2$  dissolves  $\text{CaCO}_3$  (calcium carbonate) freely, which, when the gas escapes on exposure to the air, is deposited. In limestone regions, the water trickling down into caverns has formed "stalactites," which depend from the ceiling, and "stalagmites", that rise from the floor. These frequently assume curious and grotesque forms, as in the Mammoth Cave. Sr and Ba are very much like Ca. The first is used in making crimson flames. The principal compounds are  $\text{Ba} (\text{NO}_3)_2$ , used for making green flames in fireworks, and  $\text{Ba Cl}_2$  used for detection of sulphuric acid and its salts.

46. Of what is Mg the symbol?

ANS.—Of Magnesium, a soft, silver-white metal found in hornblende, meerschaum, soap-stone, talc, and other rocks. Its salts give the bitter taste to sea-water.  $\text{Mg-Co}_3$  is the "magnesia alba" or common magnesia of the drug store.

*Experiment.*—Taking some of this white powder, warm it in a test tube with a few drops of sulphuric acid, when the powder will

dissolve. Then pour the clear solution into a porcelain basin, and boil off the greater part of the water. On cooling, some long needle-shaped crystals will be found in the basin. These crystals are magnesium sulphate, or Epsom Salts; a compound of magnesia and sulphuric acid.

#### 47. From what is Aluminum named?

Ans.—Al is named from alum, in which it occurs. It is also called the "clay metal", and is the metallic base of clay, slate, mica, and feldspar rocks. It is a bright, silver-white metal and next to O and Si is probably the most abundant element of the earth's crust. The manufacture of the metal is expensive, owing to the difficulty of separating O from the clay. The most important salt is ammonium alum, a double sulphate of Al and K or  $H_4N$ . The hydrate  $Al_2(HO)_6$  is used for "fixing" dyes.

#### 48. What is glazing?

Ans.—Spreading a mixture of the coarse materials from which glass is made over the article, and then heating till it melts and forms a glazing over the clay. Ordinary stoneware is glazed by simply throwing damp NaCl into the furnace. This volatilizes, and being decomposed by the hot clay makes a sodium silicate over the surface, while fumes of HCl escape. The color of pottery-ware and brick is due to the oxide of iron present in the clay.

#### 49. How have many of the metals been discovered?

Ans.—By Spectrum Analysis. Various metals impart a peculiar color to flame. Na gives a yellow tinge, copper a green, Sr a crimson, etc. If we look at these colored flames through a prism, we see, instead of the ordinary "spectrum," a dark space strangely ornamented with

bright-tinted lines. Each metal makes a distinctive spectrum, even when the flame is colored by several substances at once. By this delicate method of analysis  $\frac{1}{180000000}$  of a grain of Na can be detected in the flame of an alcohol lamp.

*Query*—What two metals can be obtained from sodium? How much salt is there in the Ocean? A gallon of sea-water contains how much salt? Where is Lithium found? For what is lime valuable? How is "hard finish" made? What is mortar? What per cent of  $\text{CO}_2$  is fatal? What is mordant? Where must sodium be kept? What is the most abundant of all the elements? How many alums are there?

### 50. What is the symbol of civilization?

ANS.—Iron. Fe is rarely found native, but is dug from "mother-earth" as an ore from which the metal is obtained with difficulty. Meteors, however, containing as high as 93 per cent. of Fe associated with Ni and other metals, have fallen to the earth from space. One most useful ore of iron is red iron oxide, called *haematite* iron ore. By heating this with charcoal the oxygen is eliminated, and the metal Fe remains. After puddling this is called wrought or malleable Fe, because it can be hammered and made (when red hot) into anything which is wanted. This form is very useful because when hot two pieces of Fe can be *welded* together so firmly that they can not be separated.

NOTE.—Cast-iron is made from iron ore and coal, and limestone, by placing these minerals in blast furnaces. Cast-iron is brittle and breaks into pieces under the hammer. By a process called *puddling*, the carbon, which the cast-iron has obtained from the coal is burnt away. It is an exception to the law that "cold contracts," since at the very instant of solidification it expands, so as to copy exactly every line of the mould into which it is poured.



## 51. How is steel made?

ANS.—It contains less C than cast, and more than wrought iron, and is made from the former by burning out a part of the C, and from the latter by heating in boxes of charcoal, and so adding C. The value of steel depends largely upon its temper.

NOTE.—In 1730, there lived at Attercliffe, near Sheffield, a watchmaker named Huntsman. He became dissatisfied with the watch-springs in use, and set himself to the task of making them homogeneous. "If," thought he, "I can melt a piece of steel and cast it into an ingot, its composition should be the same throughout." He succeeded. His steel became famous, and Huntsman's ingots were in universal demand. He did not call them cast-steel. That was his secret. The process was wrapped in mystery by every means. The most faithful men were hired. The work was divided, large wages paid, and stringent oaths taken. One mid-winter night, as the tall chimneys of the Attercliffe steel-works belched forth their smoke, a belated traveler knocked at the gate. It was bitter cold; the snow fell fast; and the wind howled across the moor. The stranger, apparently a common farm laborer seeking shelter from the storm, awakened no suspicion. The foreman, scanning him closely, at last granted his request and let him in. Feigning to be worn-out with cold and fatigue, the poor fellow sank upon the floor and was soon seemingly fast asleep. That, however, was far from his intention. Through cautiously opened eyes he caught glimpses of the mysterious process. He saw workmen cut bars of steel into bits, place them in crucibles, which were then thrust into furnaces. The fires were then urged to their utmost intensity until the steel melted. The workmen, clothed in rags, wet to protect them from the tremendous heat, drew forth the glowing crucibles and poured their contents into moulds. Huntsman's factory had nothing more to disclose. The secret of cast-steel was stolen.

*Experiment.*—Place about a table-spoonful of  $\text{FeS}$  in a bottle. Pour in two or three teaspoon-fuls of  $\text{HCl}$ . Pass the end of the delivery bottle into a bottle of cold  $\text{H}_2\text{O}$ .  $\text{H}_2\text{S}$  gas is generated and will be partly dissolved in  $\text{H}_2\text{O}$ . It is readily recognized from its offensive odor, which is similar to that of decayed eggs.  $\text{FeS} + 2\text{HCl} = \text{FeCl}_2 +$



$H_2S$ . Remark.  $H_2S$  is a test for silver, lead, etc. This explains why silver spoons are blackened when used with eggs.

*Experiment 2.*—Into a clean wine glass, pour a few drops of Tincture of Galls; to this add a solution of  $FeSO_4$ —a purple color, changing to black, is the result. *Rationale.* This black fluid is Ink, formed by the combination of the Gallic acid of the Tincture, with the iron, forming Gallate of iron, which is black.

## 52. Describe Manganese.

ANS.—Mn is related to Fe and Cr, is obtained from  $MnO_2$ ,  $Mn_2O_3$ , and is seldom used except in compounds. By fusing  $MnO_2$ ,  $KClO_3$ , and  $KHO$ , a dark, green mass is obtained called "*chameleon mineral*."  $K_2O$ ,  $Mn_2O_7$  or  $KMnO_4$  is used as an oxidizing agent and disinfectant. Mn compounds are also used for coloring glass, and in the preparation of Cl.

## 53. What is Zinc?

ANS.—Zn or "spelter" is found as  $ZnO$  (*red oxide*) and as  $ZnS$  (*blende*) or zinc sulphide. It is used in galvanic batteries, and in sheet form for roofing.  $ZnO$  is a light white powder when cold, yellow when hot, and used in paint as "zinc white." Zinc sulphate ( $ZnSO_4$ ), *white vitriol*, is used in medicine.

## 54. How is tin reduced?

ANS.—From its binoxide by the action of C. Sn is a bright white metal, much used for "plating" iron. Common tin-plate is really iron-plate, which is covered with Sn by dipping Fe into melted Sn. This coating preserves Fe from rust. Sn is used in making such alloys as pewter,

Britannia metal, etc. Its most important ore is an oxide of tin, known as "tin stone" found in Cornwall, England.

*Query.*—How do brass pins get their white surface? What is the "tin-cry"? How is the temperature of steel determined? What is the meaning of Ferrum? What is *spath*? Gray cast-iron contains what per cent. of C? What is spiegel-eisen? Define "Fool's Gold." Describe Bessemer's Process. What is  $\text{Fe So}_4$ ,  $7\text{H}_2\text{O}$ ? How is galvanized iron prepared? What is Philosopher's Wool? What is the fusing point of Tin?

55. What metal is found near Lake Superior?

Ans.—Copper. Cu is a reddish colored metal found native in Minnesota and is also obtained from copper ores, of which there are several kinds. Cu is much used in mixing with other metals yielding an alloy, such as brass and bronze. When copper is heated in the air, it tarnishes, and then becomes covered with a black coating of oxide ( $\text{CuO}$ ), which is very poisonous.

*Experiment.*—Place some copper filings in a dish and pour on them a few drops of nitric acid. Dense brownish red fumes will be given off from the nitric acid, and a *blue* solution of copper nitrate will be formed.

NOTE.—There is no real distinction between organic and inorganic chemistry, many compounds found first in living bodies, and supposed to be formed in them, having been artificially produced. While inorganic bodies deal with sixty-four elements, organic are composed principally of only four, C, H, N, and O. As O is their characteristic element, they are frequently styled the "carbon compounds." Bodies which contain the same elements in the same proportions by weight, and yet exhibit different physical and chemical properties, are called Isomeric, and may be so from two causes.

56. What is the most common ore of Lead (Pb)?

Ans.—Galena ( $\text{PbS}$ ), from which it is obtained by oxi

dizing the S in a furnace. It is a bluish-gray metal, poisonous, soon losing its luster by oxidation; very malleable, very soft, and but slightly ductile or tenacious; when heated it forms litharge,  $\text{PbO}$ . At still greater heat, red lead or  $\text{Pb}_3\text{O}_4$ , acted upon by  $\text{HNO}_3$ , acetic acid.

NOTE.— $\text{H}_2\text{S}$  is the test of Pb with which it forms the lead sulphide,  $\text{PbS}$ . Add a little gum-arabic to a solution of lead acetate to prevent the mixture from flowing too freely from the pen and then make a drawing of any subject. This sketch, when dry, will be invisible. When ready for use, dampen the paper slightly on the wrong side, and then direct against it a jet of  $\text{H}_2\text{S}$ . The picture will at once blacken into distinctness. The lead acetate is a virulent poison, with a sweet, pleasant taste.

### 57. What is smelting?

ANS.—The process of getting the metals from the ores. That branch of science which treats of the formation, origin and working of metals, is called metallurgy.

EXPERIMENT.—Add a small solution of potassium chromate to a glass of water, in which there is a solution of lead acetate. A splendid yellow precipitate of lead chromate, or chrome yellow will be produced. Again dissolve a little "sugar of lead" in water and fill a clean vial with the solution. If a piece of Zn, cut in small strips, be suspended in the vial, the Zn will blossom out with beautiful crystals of metallic lead. The Pb has been deposited upon the Zn by chemical action. This is called the "Lead-Tree."

### 58. Name the *noble metals*.

ANS.—Gold, Silver, Platinum, Mercury, Palladium, Iridium, Osmium, Ruthenium, and Rhodium. Au is the most valuable of metals. It has a beautiful yellow color and is one of the heaviest of the known metals. It pos-

sesses great ductility, can be drawn out into very thin wire or beaten into thin plates called *gold leaf*, which is much used for gilding. Au never tarnishes in the air or becomes stained with S like Ag and consequently has been used in jewelry and for coin from the earliest times.

EXPERIMENT.—Gold will not dissolve in any one acid. Taking a leaf of gold, divide it into two pieces, and place each piece in a separate glass. Pour upon one a little hydrochloric acid; upon the other a little nitric acid. The Au in neither glass will dissolve, but mix the two and the metal will rapidly disappear.

Query.—What is the green coating that gathers upon brass or copper? What is “blue-stone?” What are the uses of  $\text{CuSO}_4$ ,  $5\text{H}_2\text{O}$ ? Describe the “Music of Science.” What is an *amalgam*? Describe the process of gold-washing in Australia and California. What is White-Lead?

### 59. Which is the whitest of the metals?

Ans.—Ag, whose common form is black sulphide,  $\text{Ag}_2\text{S}$ ; horn-silver  $\text{AgCl}$ ; or ruby-silver when united with S and As or Sb. It is very malleable, ductile and an excellent conductor of heat and electricity. Of its compounds silver nitrate ( $\text{AgNO}_3$ ) sold in small, round sticks as *lunar caustic* is the most extensively used, being the basis of indelible inks and hair-dyes, and also of photography and daguerreotyping.

### 60. Describe Platinum.

Ans.—Pt is the most important of the tetrad group. It is of a whitish color resembling Ag in appearance and has such extreme ductility that wire is made from it so fine as to be invisible to the naked eye. The largest nugget of Pt ever found weighed 18 lbs. Spongy Pt absorbs



200 times its volume of O. The "ore," as it is called, is separated from the earthy particles by washing.

61. What is "quick-silver?"

Ans.—The common name of mercury (Hg), so called because it moves about as if it had life, and was supposed by the alchemists to contain silver. It is prepared by roasting  $\text{HgS}$  in the open air. The S passes off as  $\text{SO}_2$ , while the Hg volatilizes and is condensed in earthen pipes. It is the only metal liquid at ordinary temperatures, freezes at  $-40^\circ$ , and boils at  $662^\circ$ . It is widely used for thermometers, for silvering mirrors, and in its amalgams, which it forms with most metals.  $\text{HgCl}$ , calomel;  $\text{HgCl}_2$ , corrosive sublimate;  $\text{HgO}$ , "red precipitate;" and the two iodides, are the chief compounds.

NOTE.—Hg is found native in Mexico in very small quantities, where the mines are said to have been discovered by a slave, who, in climbing a mountain, came to a very steep ascent, and to aid him in surmounting this, tried to draw himself up by a bush which grew in a crevice above. The shrub, however, giving way, was torn up by the roots, and a tiny stream, of what seemed liquid silver, trickled down upon him.

62. Pd is the symbol of what?

Ans.—Palladium, which ranks next to Pt, to which it has a strong resemblance. It is acted upon by the common acids, and "occludes" 900 times its volume of H. Pt and Pd both form bi- as well as tetra-chlorides. Ir, Os, Ru, and Ro are used as "iridosmine" for the nibs of gold pens.

63. Name some of the alloys.

Ans.—German Silver, Britannia, Brass, Pewter, Soft Solder, Bronze, Fusible Metal, etc. Their compounds can



be learned by reference to any general work on Chemistry. Au is soldered with an alloy of itself and Ag; Silver, with itself and Cu; Copper, with itself and Zn. Gold coin consists of *nine* parts of gold and *one* of alloy. The alloy is composed of 9 parts of Cu, whitened by 1 of Ag, so as not to darken the gold coin. Silver coin is *nine* parts of Ag and one of Cu. The nickel cent is 88 parts of Cu and 12 of Ni. Cu being cheaper than Ni, is used to make the coin larger.

#### 64. What is the meaning of Stibium?

Ans.—It is the classical name for Antimony. Sb is found native and also in combination with O, S, and some metals; obtained from Stibnite,  $Sb_2S_3$ , by roasting with Fe. It is a brittle, bluish, white solid, melts at  $450^\circ$ , and burns with a white flame at red heat. It is used in type-metal and pewter. K, SbO,  $C_4H_4O_6$  forms tartar emetic;  $SbCl_3$  is used in bronzing gun barrels and  $Sb_2S_3$  in blue signal-lights.

NOTE.—Sb was discovered by Basil Valentine, a monk of Germany, in the fifteenth century. It is said that, to test its properties, he first fed it to the swine kept at the convent, and found that they thrived upon it. He then tried it upon his fellow-monks, but perceiving that they died in consequence, he forthwith named the new metal, in honor(?) of this fact, *anti-moine* (anti-monk), whence the term *antimony* is derived.

#### 65. For what purpose is Bismuth used?

Ans.—Bi, a brittle, reddish metal is used in alloys for reducing the fusing point and giving a clearly defined image, and also in thermo-electric batteries.

NOTE.—Nickel (Ni) and Cobalt (Co) are found native in meteors and also as sulphates or arsenides. The former is mined in Pennsylvania for the United States government to make into cents. These metals resemble Fe, but are not readily acted upon by acids.

Ni is much used for plating; forms but one salt, the sulphate of a beautiful green tint. Co forms a nitrate.  $\text{Co}(\text{NO}_3)_2 + 6\text{H}_2\text{O}$ , used in blow-pipe analysis and for coloring glass.

66. What are the combining weights of some of the elements?

Ans.—O=16; H=1; Si=28; Sn=118; Fe=56; Ag=108; Au=197; C=12; Cl=35; P=31; Hg=200; Pb=207; Na=23; Cu=63; Zn=65; Pt=? L is the lightest liquid known. Pt is the heaviest solid. The most common color is *white*. Steel is the most, and lead the least tenacious of the metals.

Query.—Which are the most malleable? Most brittle? What is the melting point of the different metals? How is paper *sensitized*? From what did Priestly discover O gas? What alloy consists of Bi, Pb, and Sn? What is formed by a union of Cu, Zn, and Ni? Why is an alloy used in gold or silver coin? What does the term *carat* mean when applied to the precious metals? What is *coelistine*?

67. From what are carbon compounds derived?

Ans.—From the four simple compounds  $\text{CH}_4$ , Marsh Gas, (fatty bodies);  $\text{C}_6\text{H}_6$ , Benzine, (aromatic bodies);  $\text{C}_{10}\text{H}_8$ , Naphthaline,  $\text{C}_{14}\text{H}_{10}$  Anthracene. These derivations form analogous series of homologous compounds, i. e., compounds which differ from the preceding or succeeding ones in the series by a constant quantity, as  $\text{CH}_4$ ;  $\text{C}_2\text{H}_6$ ;  $\text{C}_3\text{H}_8$ ; which differ from each other by the constant quantity  $\text{CH}_2$ .

68. What is the compound  $\text{C}_6\text{H}_{10}\text{O}_5$ ?

Ans.—Both starch and woody fibre. Starch is made from wheat, corn, potatoes, etc. The process is essentially the same in all. In fermentation, starch absorbs  $\text{H}_2\text{O}$  and changes to sugar; again absorbing water, it changes to

grape sugar. In the presence of a ferment the grape sugar is changed to  $\text{CO}_2$  and alcohol, which being oxidized in air becomes acetic acid.

### 69. What is yeast?

ANS.—It is formed during the process of fermentation. It consists of microscopic plants (*mycoderma cerevisiae*) which increase by the formation of multitudes of tiny cells not more than  $\frac{1}{250}$  of an inch in diameter. In the brewing of beer they spring up in great abundance, making common brewer's yeast.

NOTES.—Porcelain cement is made by stirring plaster of Paris into a thick solution of gum-arabic, and is best applied with a brush. Horn is colored by boiling it in infusions of colors. Tar is made, like charcoal, by burning heaps of wood under a covering of earth which excludes the air. For attaching labels to glass or porcelain, gum tragacanth is generally employed. Coal-tar is formed in the process of making coal-gas.

### 70. Name the organic or vegetable acids.

ANS.—*Citric acid*, found in the lemon, strawberry, gooseberry, and raspberry. *Tartaric*, in the grape. *Malic*, in unripe apples. *Oxalic*, in rhubarb. *Tannic*, in the leaf and bark of trees.

NOTE.—The organic bases or alkaloids are the bases of true salts found in plants producing opium, nicotine, quinine, morphine, caffeine, and theine.

### 71. What are the coloring substances?

ANS.—Madder, Brazil-wood, Indigo, Litmus, Logwood, Cochineal, and Leaf-green or chlorophyl. The purple of which we read in ancient writings was a secret with the Tyrians. King Hiram, we learn, sent a workman to Solomon skilled in this art. The dye was obtained from a shell-

fish that was found on the coast of Phoenicia. Each animal yielded a tiny drop of the precious liquid. A yard of cloth dipped twice in this costly dye was worth \$150.

## 72. What is Qualitative Analysis?

ANS.—The analysis of inorganic substances; for which purpose it is only necessary for the student to familiarize himself with the reactions of about twenty-six metals and a dozen acids. To be able to apply these tests with certainty, in all cases, and to know the easiest and best methods of dissolving the substance, constitute a qualitative chemist.

NOTES.—Mezzotinto owed its invention to the simple accident of the gun-barrel of a sentry becoming rusted with dew. Gold and platinum are distinguished from all other metals by their insolubility in  $\text{HCl}$  or  $\text{HNO}_3$ , but are converted into soluble chlorides by *aqua regia*. Celluloid is a composition of fine tissue paper and camphor, treated with chemicals by a patent process. Combustion is properly the union of bodies with constituents of the surrounding atmosphere; usually, however, the term is applied to the rapid oxidation of objects in air, accompanied by light. Decay is simply a slow form of oxidization.  $\text{H}_2\text{O}$  and  $\text{CO}_2$  are the products of combustion in the animal body as well as in the flame.

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## Brain-Strainers.

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What is rennet? If you ask for Vitriol at the drug-store, what do you receive? What is the difference between fixed and volatile oils? How does a resin become a balsam? What are albuminous bodies? What follows alcoholic fermentation? What do you know of domestic chemistry? What are the beneficial results of toasting bread? Define radicals. Describe cochineal. Where is the "Home of the Gold?" How is *chrysoprase* colored? Describe the

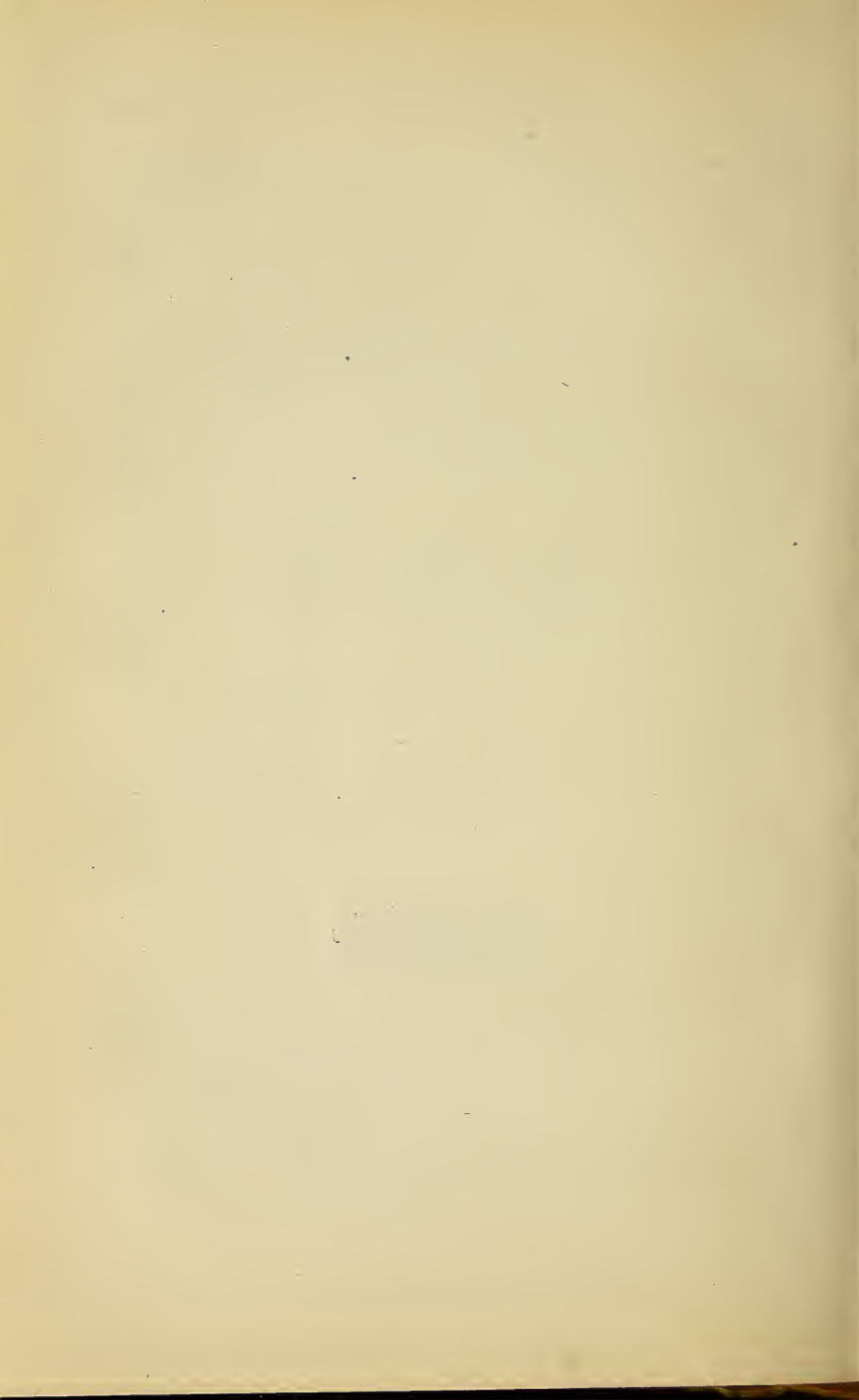


manufacture of shot. What is Oreide? What is "aluminium bronze"? Express the compound for cane sugar. Rust is what? Paper is made from what? How is linen made? What are *metameric* and *polymeric* compounds? What is the test for adulterated candy? Define Allotropism. What is Pyroxylin? Can sugar be made from an old shirt? What occasions kerosene accidents? How can you show that vegetable matter contains carbon? Who ate Roger Williams? What is the *volvax globator*? For what purposes is  $\text{HNO}_3$  used? How is lampblack obtained? Where is Bunsen's Burner used? Describe the oxy-hydrogen blow-pipe. What is the meaning of the term *cyanogen*? How is the calcium light formed? What element exists in the enamel of the teeth? What is the common name of Hydrocyanic acid ( $\text{HCy}$ )? What is its antidote? Ans.  $\text{H}_3\text{N}$ . Is there a "California" of iron? What is used in forming a *yellowish* glaze? What is chalk? Describe malachite. How much S in a lb. of  $\text{H}_2\text{SO}_4$ ? What was manufactured in the mammoth cave of Kentucky during the war of 1812? What is the common name of sodium carbonate? Of yellow lead oxide? What is the chemical name of white lead? Of table salt? How can you prove the alloy of a coin? What is cupellation? Describe the photographic process. What is *frosted silver*? From what is iridium named? What is the cause of "painter's colic"? What is the meaning of the word *platinum*? Of what is "iodized collodion" composed? What does the nitrate of silver bath contain? What is coke? British Lustre? What is catalysis? Define the term *native*. What is the specific gravity of Mg,  $\text{HyN}$ , Al, Sn, Pb, and Fe? What is the atomic weight of the metals?  $\text{KNO}_3 + \text{H}_2\text{SO}_4 =$  what? How was the process of whitening sugar discovered? What was the origin of Lithographing? Is the oxalic acid in the pie-plant poisonous? What are the



proteine compounds? What is the composition of Petroleum? Of Meerschaum? Of laughing Gas? What are derivatives? Are you familiar with both the old and the new nomenclature? What is the process of making gold-leaf? Why is "pig-iron" so called? What is *chromic anhydride*? What weight of NaCl would be required to form 25 lbs. of muriatic acid? Is saleratus a salt of Na or of K? What oil is *unctuous*? What parts of an inhabited room generally contain the greatest quantities of deleterious gasses? What is an atmosphere? With what is the venom of the rattlesnake isomeric? How are salts formed? What are anhydrides? What is meant by saying that Zinc is *positive* to every other metal? Are alkalies bases? Brass is a mechanical mixture of what? All true acids are compounds what? What is likely to be mistaken for arsenic? What is the meaning of C. P.?





**GEOLOGY AND MINERALOGY.**



# GEOLOGY & MINERALOGY.

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## 1. What is the meaning of Geology?

ANS.—The word is derived from two Greek words signifying *the story of the earth*.

NOTE.—Mineralogy treats of substances simply as they are found in nature, without regard to any action that might be induced by mingling them together. It is preparatory to Geology, because it gives us a knowledge of the mineral substances which make up the rocks.

Query.—What is a liquid mineral? What is composed of the two mineral gases, oxygen and hydrogen? Are minerals solid?

## 2. Define crystallization.

ANS.—When a mineral substance takes on a solid form, the atoms or particles are disposed to an arrangement which is termed *crystallization*. It is very definite and exact, with straight lines, perfect angles, and plane, smooth faces. Crystals of quartz, commonly called *rock crystal*, are familiar examples. Mica is another of quite a different kind, the crystals being *foliated*—that is, in leaves.

NOTE.—Quartz crystals are sometimes very large. There is one at Milan which is  $3\frac{1}{4}$  feet long,  $5\frac{1}{2}$  in circumference, and weighs 870 pounds.

## 3. What is rock?

ANS.—The crust of the earth is made up of a variety of solid materials to which the general term *rock* is given. Not only are stony and compact rocks like sandstone, lime-



stone or granite, included under this term, but soft and loose matter such as clay and sand. All solid matter not immediately derived from animal or vegetable sources, but which occurs naturally in large masses, is called rock by geologists.

#### 4. What are minerals ?

ANS.—The distinct substances composing rocks are called *minerals*. While some rocks, such as limestones, have the same composition throughout, others are formed of a mixture of crystals or small particles of different kinds.

*Query*.—Of what does Geology treat ? Rocks consist of what ? What is an *ore* ? What are the characteristics of quartz ? Describe the *cairngorm stone*.

#### 5. What are silicates ?

ANS.—The name is given to those minerals containing silica. While this substance exists abundantly in rocks as quartz, it makes also, on an average, a third of all their other minerals, limestones excepted. Silica is derived from the Latin word *silex*, meaning flint.

#### 6. Define Amorphous and Dimorphous.

ANS.—A mineral is said to be *amorphous* when it is destitute of all trace of crystalline form. When a mineral appears in crystals of two forms, sometimes the one and sometimes the other, it is said to be *dimorphous*—*dis*, twice, and *morphe*, form.

#### 7. What is one of the most important of minerals ?

ANS.—Carbon, which is one of the four grand elements

In the composition of vegetable and animal substances. It is known under different forms as the diamond, graphite, coal, etc.

NOTE.—The art of cutting and polishing diamonds was unknown till 1456, when it was discovered by Louis Berquen, of Bruges. In speaking of the size of diamonds the term *carat* is used. This is the name of a bean, which was used in its dried state by the natives of Africa in weighing gold, and in India in weighing diamonds. Though the bean is not used for this purpose now, the name is retained, and the carat is nearly four grains Troy.

### 8. What are the compounds of sulphur?

ANS.—Sulphide of Lead, Sulphide of Iron, Sulphide of Silver, Sulphide of Antimony, the two sulphides of Arsenic, Sulphate of Lead, Sulphates of Magnesia and of Soda, Sulphate of Baryta, Sulphuric and Sulphurous acids, etc.

### 8. Name one of the most common of mineral compounds.

ANS.—Bisulphide of iron which has been known from ancient times. It is generally termed pyrites, from the Greek word *pur*, meaning "fire." Pliny says, "there is much fire in it," referring to its readily striking fire with steel.

NOTE.—Gypsum is a white and soft mineral, and appears in many forms, some of which are very beautiful. One of these is the *satin spar*, so called from the splendid lustre of its delicate fibrous arrangement. Common limestone has sometimes been mistaken for gypsum.

Query.—How can this error be avoided? Name the "three vitriols." Define *realgar* and *orpiment*. What is cleavage? What are *bort*? Define *slag*.

10. How do we obtain metals from their ores?

ANS.—Frequently by a very simple process. In the case of bismuth, all that is necessary is to heat the pounded ore and the melted metal runs out. With mercury, antimony, or sulphide of lead, heat will fully decompose the compound, driving off the sulphur. An oxide of iron is heated with charcoal. The oxygen leaves the iron to unite with the carbon, forming carbonic acid, when the latter departs, leaving the metallic iron.

11. In what does native iron occur?

ANS.—In meteorites, and there it is alloyed with nickel, and with a small amount of other metals, such as tin, cobalt, copper, and manganese.

12. From what is the word *hematite* derived?

ANS.—From the Greek word *haima* (blood). This oxide is distinguished from the magnetic iron ore by its powder being *red*. This mineral appears in various forms, red chalk being one of the varieties.

13. Describe chromic iron.

ANS.—It is composed chiefly of the oxides of two minerals, iron and chromium. Two other components are alumina and magnesia, which vary in quantity in different specimens. This mineral is quite abundant at Barehills, near Baltimore, in Lancaster county, Pennsylvania, and several other places in the country. Its crystals are octahedrons. For what is it valuable?

Query.—What are "California diamonds?" Name the varieties of quartz. Define hydrated oxide. What is a dodecahedron? What do we mean by saying that the hardness of Quartz is 7? (Talc is 1, and Diamond is 10). Describe the two carbonates of copper.

NOTE.—The tin used in making tin ware is iron in the form of sheets covered with tin, which does not oxidize as readily as tin does. The chief tin mines are at Cornwall, in England, in the island of Banca, in Malacca, and in Austria.

#### 14. Give an account of salt.

ANS.—This is composed of chlorine and sodium, two elements which never appear in nature uncombined. Its crystals are the cube and its secondaries. This mineral is very thoroughly diffused in the earth, mostly, however, in solution, nearly  $\frac{1}{30}$  of all the water in the sea being common salt. Lakes that have no outlet to the sea are very salt. This is the case with the Great Salt Lake, the Dead Sea, and the Caspian Sea. Over  $\frac{1}{5}$  of the water of the Great Salt Lake is salt, and the proportion is even greater in the case of the Dead Sea. There are famous salt mines where the solid mineral is obtained in Poland, Hungary, Spain, Sicily and Switzerland. In the extensive mines near Cracow, chapels and halls are excavated far below the surface, their roofs being supported by immense pillars of salt, which, on being lighted, present a magnificent appearance. In northern Africa there are hills of salt. In this country vast quantities of salt are obtained by evaporation from the water of salt springs. The springs in Onondaga county, N. Y., are the most productive,  $\frac{1}{4}$  part of the water being salt. In hot climates, much salt is obtained from sea-water by evaporation.

#### 15. What is marble?

ANS.—The finest white marble, like that of Carrara in Italy and the island of Paros, of which the most delicate statues are carved, is *carbonate of lime* altered and hardened by volcanic heat.

NOTE.—To make mortar of lime, it must be softened and then

brought into a state in which it can be hardened again. This discovery was probably very ancient; and made, probably like most of the old discoveries, in the East, spreading westward gradually. The earlier Greek buildings are cyclopean, i. e., of stone fitted together without mortar. The earlier Egyptian buildings, though the stones are exquisitely squared and polished, are put together without mortar. The famous aqueduct of the Pont du Gard, near Nismes, in the south of France, has no mortar whatever in it, [The stones of its noble double tier of circular arches have been dropped into their places upon the wooden centres, and stand unmoved to this day, simply by the jamming of their own weight; a miracle of art.

16. Name the classes of rocks.

ANS.—Stratified, fragmentary, arenaceous, argillaceous, calcareous, carbonaceous, metamorphic, igneous, volcanic, and granitic.

17. What is said of the aqueous origin of stratified rocks?

ANS.—The surface rocks of the land are continually being worn away by the action of rain, frost, running water, and other natural agents. The wasted material is carried away by streams and rivers into lakes or the sea, where it collects at the bottom, forming layers or beds. Sea-breakers act destructively on the coasts, tearing away particles and fragments, and rolling them outwards into deeper water, where they accumulate, and form beds similar to those formed by the material brought down by rivers. Mineral matter enters into the composition of these beds, and the remains of marine animals become buried in the sediments which are forming.

18. What is conglomerate (*puddingstone*)?

ANS.—A rock consisting of pebbles cemented together, the cementing material filling the interstices and render-



ing the whole compact. *Breccia* is a rock consisting of angular fragments consolidated into hard stone.

### 19. Define mud?

Ans.—A finely-powdered mineral matter, generally mixed with particles derived from vegetable and animal sources. It is the result of the waste of rocks by running water and other natural agents. Mud is the ultimate product of the action of these agents on the softer rocks, and of their prolonged action on the harder ones.

### 20. What resembles mud?

Ans.—Clay does in the fineness of its particles, but the particles adhere together, forming a tough material easily moulded by the fingers. *Shale* is hardened mud or clay which splits into thin plates or laminae parallel to the stratification. Such a rock is said to be *laminated*.

NOTES.—*Oolite* or *Roe Stone* is a limestone made up of small round grains, which gives it a structure resembling the roe of a fish. *Pisolite* or *peagrit* has a similar structure to oolite, but the grains are flat and as large as peas. *Dolomite* is a variety of magnesian limestone more or less crystalline. The crystals are small and compact. *Marl* is calcareous clay.

### 21. What are metamorphic rocks?

Ans.—Stratified rocks which have undergone a change of structure since they were deposited. Their stratified character leaves no doubt of their sedimentary origin, but frequently all other traces of aqueous agency are obliterated, and they become more or less crystalline.

### 22. Describe mica schist.

Ans.—It is a rock consisting of alternate laminae of

mica and quartz. The original texture of the rock is quite obliterated. It readily splits into thin laminæ or plates of *different mineral matter*. Such mode of division is called *foliation*, and rocks which so divide are called *foliated* or *schistose*.

*Query.*—Of what is gneiss composed? What is *serpentine*? Name the forms of calcareous rocks. What is "quartzite"? Define sandstone, flagstone, and gritstone. What is sand? loam? Explain the difference between a *siliceous conglomerate* and a *calcareous conglomerate*.

23. What are the various forms of igneous rocks?

ANS.—Granite-like rocks (including granite, syenite, and hyposyenite), diorite, dolerite, peridotite, porphyry, trachite, lava, and scoria. *Scoria* is a light lava, full of cavities, like a sponge; and *pumice*, a white or grayish feldspathic scoria, having the air-cells long and slender, so that it looks as if it were fibrous.

24. Under what three conditions do rock-masses occur?

ANS.—Stratified, Unstratified, Vein form. Stratified rocks are those which lie in beds or strata. The word *stratum* (the singular of strata) is from the Latin, and signifies that which *is spread out*.

NOTE.—It is from stratified rocks that geologists glean the history of the earth in past ages. Their position reveals the different convulsions of the earth by which their horizontal position has been disturbed. A *layer* is one of the sub-divisions of a stratum; i. e., a stratum may consist of an indefinite number of layers.

25. What are unstratified rocks?

Ans.—Those which do not lie in beds or strata. Mountain-masses of granite are often without any appearance of stratification. The rock of the Palisades, on the Hudson, stands up with a bold columnar front, and has no division into layers. There are similar rocks about Lake Superior.

## 26. Describe the vein-form condition.

Ans.—When rocks have been fractured, and the fissures thus made have been filled with rock-material of any kind, or with metallic ores, the fillings are called *veins*. Veins, therefore, are large or small, deep or shallow, single or like a complete network, according to the character of the fractures in which they were formed. They may be as thin as paper, or they may be yards, or even rods in width,

## 27. Name some of the dislocations of strata.

Ans.—Most of the strata of the globe have lost their original horizontal position, and are more or less inclined; some are even *vertical*. The following are terms used in describing the positions of strata. Outcrop, Dip, (when the strata slant they are said to be *inclined*), Anticlinal, Synclinal, Monoclinical, etc. When two strata dip in different directions from a common ridge they are said to form a *saddle back*. The headland or bluff formed by the end of a number of strata is called an *escarpment*.

NOTE.—The layers of stratified rocks always occur in regular order; we do not mean that every variety of stratified rock will be found by digging from the surface of the earth downward, but that no rock will be found out of its regular order in a series unless the strata has been torn asunder by disrupting causes. For instance, it would be useless to dig for *coal* below *clay slate*, or for *chalk* below *coal*, while the latter would be likely to underlie *magnesian limestone*. A certain stratum may be missing, but if it is, the re-

maining strata will occupy their original position in regard to each other.

*Query.*—What word is formed from  $\gamma\tilde{\eta}$  and  $\lambda\acute{o}\gamma\omicron\varsigma$ ? What is gravel? What is the "toad-stone?" What is a formation? A group? Describe *tufa*. Define *itacolumite*. What are rill-marks? A *basin* is what?

## 28. What is known of the origin of granite?

*Ans.*—Nothing. The foundation upon which the soil and loose rocks of the earth rest is composed of *granite*, or granitic rocks; hence, when the poet speaks of anything being as firm as the "eternal granite," his simile is grandly true.

## 29. Of what is granite composed?

*Ans.*—In its pure state it is formed of quartz, feldspar, and mica; the first forming the hard flinty crystals, the second, the soft grayish particles which can be easily scratched, and the mica forming the shining transparent scales.

*NOTE.*—When the feldspar contains a large proportion of oxide of iron (iron rust) the granite is of a reddish color. When hornblende, a dark green or black mineral, takes the place of the mica, the granite is then called Syenite, from Syene in Egypt where it is very abundant.

## 30. Where is granite found?

*Ans.*—It is quarried in great quantities in the Eastern States for building purposes. New Hampshire and Massachusetts are noted for their extensive beds. They may be called the Granite States of the Union. The granite is detached in blocks by drilling a series of holes, one every few inches, to a depth of three inches, and then driving in wedges of iron between steel cheeks. In this manner



masses of any size split out. There is a choice of direction, as the granite has certain directions of easiest fracture. Masses 120 feet in length have been obtained at some of the quarries. Granite was highly prized by the ancients. There are granite obelisks in Egypt which have stood for 3,000 years. Pompey's Pillar and several of the principal Pyramids are composed of this material.

*Query.*—What is Cleopatra's Needle? Have you read "Kingsley's Town Geology?" Of what is Bunker Hill Monument built? What is porphyry? What other names are applied to Andalusite? Name some works of art wrought from Parian marble. From what are slate-pencils made? What are trap-rocks? Where is there some noted trappean scenery?

### 31. What is *kaolin*?

*Ans.*—The name given to feldspar when decomposed by the air. It is used in the manufacture of the finest kinds of china-ware.

*NOTE.*—There are many varieties of granite formed by the admixture of talc, hypersthene steatite, schorl and other minerals: but the structure of the rock is always the same, massive and irregular; and its texture is always crystalline, sometimes hard and close-grained and again coarse and loose.

### 32. Describe Zircon.

*Ans.*—A mineral which occurs in square prisms, terminated with four-sided pyramids. Its color is red, brown, or gray. Its hardness is 7.5. It is found in granite, gneiss, granular limestone, and volcanic rocks. Clear red specimens are called *Hyacinth*, to be found at Litchfield, Me., Hammond, N. Y., Franklin, N. J., and at Green River, Henderson county, N. C. At the latter place the crystals occur loose in the soil and in the greatest abundance. Clear specimens of this mineral are used for gems, and for jewelling watches.



## 33. What is Amethyst?

Ans.—A purple variety of crystallized quartz. It is colored by the oxide of manganese, or by iron and soda. It was named by the ancients, who believed that wine drunk from goblets made from this mineral would not intoxicate; and this idea is expressed in its name.

NOTE.—Amethyst has always been esteemed as a gem, but is more brilliant by sunlight than by gaslight. Fine cabinet specimens are found in Lincoln county, N. C. Small crystals are plentiful on Mount Holyoke. The finest varieties used for jewelry are brought from Brazil, Ceylon, India, Siberia, and from various parts of Europe.

## 34. Explain the difference between Onyx and Sardonyx.

Ans.—When the colors of the agate are arranged in horizontal layers or bands, it is called *Onyx*, and is the stone used in making real cameos. When the layers are sard and white chalcedony, it is called *Sardonyx*.

Query.—What is chalcedony? Give the name of the leek-green variety of chalcedony. Where is carnelian found? Moonstone and Sunstone are varieties of what? What is the hardness of mica? Name the kinds of garnet.

## 35. Of what is basalt composed?

Ans.—Augite and feldspar; it closely resembles greenstone is compact, and of a dark color. It often exhibits a columnar structure. Fine examples occur along the Columbia river in Oregon, and on the north shore of Lake Superior. Fingal's Cave, on the island of Staffa, and the Giant's Causeway, Ireland, afford wonderful exhibitions of columnar basalt.

## 36. What are the four branches of Geology?

Ans.—Physiographic, Lithological, Historical and Dynamical. Dynamical Geology treats of the causes or origin of events in Geological history,—that is, of the origin of rocks, of disturbances of the earth's strata and the accompanying effects, of valleys, of mountains, of continents, and of the changes in the earth's features, climate and living species.

37. Name the agencies of most importance.

Ans.—Next to the universal power of Gravitation, are Life, the Atmosphere, Water, Heat, and Cohesive and Chemical attraction.

NOTE.—Aqueous agencies operate in the form of Rains, Frost, Springs, Rivers, Waves, Currents, Glaciers, and Icebergs.

38. Give some illustrations of the work of life.

Ans.—Peat formations, Beds of Microscopic organisms, and Coral-reefs. Peat is an accumulation of half decomposed vegetable matter formed in wet or swampy places. In temperate climates it is due mainly to the growth of mosses of the genus *Sphagnum*. These mosses form a loose turf; and, as they have the property of dying at the extremities of the roots while increasing above, they may gradually form a bed of great thickness.

NOTE.—The roots and leaves of other plants, or their branches and stumps, and any other vegetation present, may contribute to the accumulating bed. The carcasses and excrements of dead animals at times become included. Dust may also be blown over the marsh by the winds.

39. What is said of microscopic life?

Ans.—It abounds in almost all waters. Part of the species make no stony secretions, but much the larger part

form calcareous or siliceous shells. The former (*rhizopods*), abound in the shallower waters along the borders of the ocean, and also over its bottom where it is thousands of feet deep. There are also among *plants*, the microscopic *coccoliths* covering the ocean's bed.

40. What are the siliceous species?

Ans.—Either Diatoms or Polycystines which occur both in shallow and deep waters, like the Rhizopods. The rock made of rhizopod shells is exemplified in chalk,—a soft, white or whitish limestone. That consisting of diatoms often looks like a very fine whitish earth; but it is sometimes compacted into a nearly solid mass, and sometimes into an imperfect slate. Flint is made mainly of diatoms and of the spicules of sponges.

41. Describe a coral-reef.

Ans.—The fragments and sand made by the waves, and by the same means strewed over the bottom, along with the shells also of Mollusks, commence the formation of a bed of coral-rock, literally a bed of limestone, for the coral and shells have the composition of limestone, and consolidation goes on simultaneously. As the corals continue growing over the bed, fragments and sand are constantly forming, and the bed of limestone thus increases in thickness. In this manner it goes on increasing until it reaches the level of low tide; beyond this it rises but little, because corals cannot grow where they are liable to be left for a day wholly out of water; and the waves have too great force at this level to allow of their holding their places, if they were able to stand the hot and drying sun. The bed of calcareous rock thus produced is a *coral-reef*.

NOTE.—*Dunes* are regions of loose drift-sand near the sea. In

Norfolk, England, between Hunstanton and Weybourne, the drift-sands have traveled inland with great destructive effects, burying farms and houses.

*Query.*—What are sand-scratches? Define erosion. What is meant by an “abrading action?” What occasions a *canon*? How are deltas formed? What is the meaning of Lithology?

42. Name the divisions of structural geology.

*Ans.*—Lithology and petrology; corresponding to histology and anatomy. The former is an in-door employment; the latter an out door science.

43. What is the difference between flint and chert?

*Ans.*—During the course of geological time, beds of tripolite are gradually consolidated, chiefly by percolating waters, which are constantly dissolving and re-depositing the silica; and, finally, in the place of a soft, earthy rock, we get a hard, flinty one, which we call *flint* if it occurs in the newer, or *chert* if it occurs in the older, geological formations.

*NOTE.*—As illustrative of the force of running water it is stated that the Niagara River has cut a channel through the solid rocks, 200 feet deep, 1,200 to 2,000 feet wide, and 7 miles long. The evidence is conclusive that the Falls were formerly at Queenstown, seven miles below their present situation. Still the Falls have not receded more than one foot a year for the last half century. If this has been the rate of retrocession for the whole distance,—and on account of the nature of the rocks there is no reason for supposing it greater,—it has required 36,000 years for that great excavation.

44. What are “Pot-holes?”

*Ans.*—Deep wells which are everywhere common along rapid brooks and rivers. The celebrated “Basin” at Fran-

conla Notch is one of these wells, 40 feet in diameter, and 28 feet deep. It is filled to the depth of 8 or 10 feet with pure water, which revolves with such force that it is considered a dangerous place for even an expert swimmer. No one can doubt for a moment that the entire basin has been made by the same process which is now going on there. How long the waters of the Pemigewasset have been revolving in this basin we may never know, but undoubtedly for ages.

45. What is said about the sediment of the Amazon?

ANS.—It is so charged with sediment that its waters can be detected, by their discoloration, 300 miles from its mouth. A part of the sediment brought down by this river is carried by the current of that region, and deposited on the coast of Guiana, which is thereby advancing upon the sea.

Query.—Why is Egypt called the Gift of the Nile? Where is muscovite to be obtained? What is petrosilex? Define *ferruginous sandstone*. What is prase? What is the meaning of Crystallography? What is the sp. gr. of graphite?

46. What are the three forms of frozen water?

ANS.—The ice of lakes and rivers; Glaciers; Icebergs. Glaciers are vast masses of ice, of a peculiar structure, encased in high mountain valleys. They are, in fact, the transformed snow which falls upon the mountains above the snow line. This snow is gradually transformed into the glacier just as the snow upon the roof is transformed into icicles.

41. What are *lateral moraines*?



ANS.—An accumulation of loose material all along the glacier on both sides. By this we understand the geological changes which glaciers produce, for encased as they are in the mountain valleys, they receive the rocks and earth that are detached by the frosts from the steep flanks and peaks of the adjacent mountains.

NOTE.—Besides the blocks thus carried down on the top of the glacier, many fall through fissures in the ice to the bottom, where some of them become firmly frozen into the mass, and are pushed along the base of the glacier, abrading, polishing and grooving the rocky floor below, as a diamond cuts glass, or as emery-powder polishes steel.

48. Define "*roche moutonnée*."

ANS.—Projecting eminences of rock so called have been smoothed and worn into the shape of flattened domes by the glacier as it passed over them. They have been traced in the Alps to great heights above the present glaciers, and to great horizontal distances beyond them.

49. What are "erratics"?

ANS.—Angular blocks of granite, gneiss, and other crystalline formations found on the Jura and in the great valley of Switzerland. They must have been brought over a distance of fifty miles, and their great size and angularity, after a distance of so many leagues, has justly excited wonder; for hundreds of them are as large as cottages. One in particular, composed of gneiss, celebrated under the name of *Pierre à Bot*, rests on the side of a hill about 900 feet above the lake of Neuchâtel, and is no less than 40 feet in diameter.

NOTE.—In the vicinity of Upsala, in Sweden, is a ridge of stratified sand and gravel, in the midst of which occurs a layer of marl, evidently formed originally at the bottom of the Baltic, by

the slow growth of the mussel, cockle, and other marine shells of living species, intermixed with some proper to fresh water.

50. What is the weight of an iceberg?

ANS.—As ice floats with eight-ninths of its bulk below the surface, the true thickness of the berg is nine times its height above the surface of the water.

51. Name the igneous agencies.

ANS.—Volcanoes, Earthquakes, and Thermal Springs. There are 672 volcanoes, of which 270 are active.

NOTE.—At the birth of Christ, Vesuvius was described by the Roman geographer, Strabo, as a burnt mountain, but it had never been known to show any activity. Its crater, nearly full, was covered with a dense forest, and its slopes adorned with cultivated fields, villages and cities. In the year 63, several shocks of earthquake startled the inhabitants of its delightful slopes, and sixteen years later, in 79 A. D., the first eruption occurred, after which the northern half of the mountain alone remained. The southern half was ground to powder, and the rain of hot, wet ashes was so abundant as to lay waste the fair fields upon its flanks, and to overwhelm and bury from human view, Herculaneum, Pompeii, and Stabiae.

52. What are intimately connected with volcanic phenomena?

ANS.—Thermal springs which occur in almost every country, and remote from volcanoes as well as near them. They are to be found in Virginia, West Virginia, Arkansas, the Utah Basin, Montana, and in others parts of North America.

53. How are earthquakes produced?

ANS.—They are undoubtedly caused by the action of the

heated interior of the globe upon its crust or outside part; but precisely how this molten matter operates to produce the earthquake is not fully understood. Tidal waves are also regarded as a cause.

#### 54. What is meant by vertical movements?

Ans.—Illustrated in the case of Sweden; for, while the northern portion is gradually rising, the southern section is slowly sinking below the water level. The western shores of the Chesapeake are gradually rising. The west coast of Greenland is gradually sinking.

NOTE.—Since the Christian era, parts of the coast of Italy, in the region of Naples, have undergone vertical movements, amounting to 20 or 30 feet in each direction. The record of these changes is left not only on the coast itself, but also on the columns of the temple of Jupiter Serapis, at Pozzuoli.

Query.—Of what noted earthquakes have you read? What are Geysers? Where are the volcanoes of Jorullo, Skapter Jokul, Etna, and Mauna Loa? What is "*Pele's hair*?" Define volcano. What are organic agencies? What is an Atoll? At what height above the level of the sea does a glacier melt? Ans. 3,500 feet. How is man producing geological changes? Of what are reef corals composed?

#### 55. What are Fossils?

Ans.—The remains of plants and animals found imbedded in many of the stratified rocks of every country. They are among the most important aids in making out a history of our earth. The department of Geology which treats specially of fossils, is called Paleontology.

NOTE.—These remains were known to the ancients, and considered "freaks of Nature." Tradition, which attributed to Achilles and other heroes of the Trojan war a height of twenty feet, is traceable, no doubt, to the discovery of elephants' bones near their tombs. Thus, for example, we are assured that, in the time of

Pericles, in the tomb of Ajax was found a knee-bone of that hero which was as large as a dinner plate. It was, probably, the fossil knee-bone of an elephant. The Spartans prostrated themselves before the remains of one of these animals, in which they thought they recognized the skeleton of Orestes. Some bones of a mammoth found in Sicily were considered as having belonged to Polyphemus. Even the learned of a later day were not exempt from these blunders. Felix Plater, Professor of Anatomy at Basle, in 1517, referred the bones of an elephant discovered at the roots of a tree torn up by the wind near Lucerne, to a giant at least nineteen feet high. He even restored it in a sketch which was long preserved in the college at Lucerne.

56. What fossils have been found in coal?

Ans.—Articulate animals of the genus Scorpion were found by Count Sternberg in 1835 in the coal-measures of Bohemia. From the coal of Wetting, in Westphalia, several specimens of the cockroach or *Blatta* family, and the wing of a cricket (*Acridites*), have been described by Germar. Prof. Goldenberg published, in 1854, descriptions of no less than twelve species of insects from the nodular clay-ironstone of Saarbrück, near Trèves. Among them are several *Blattinæ*, three species of *Neuroptera*, one beetle of the *Scarabæus* family, a grasshopper or locust, *Gryllacris*, and several white ants or *Termites*.

57. *Dendrite* is what?

Ans.—Delicate expansions of mineral matter, closely resembling plants, which are often found on breaking open all kinds of rocks, stratified as well as unstratified. These imitations of vegetable forms result from the infiltration of mineral matter into minute fissures, and must not be confounded with organic remains.

58. What do the fossils teach us?

Ans.—That all rocks in which they occur were once in



a soft state, like the sand and mud at the bottom of our present waters, and, occurring in successive layers, they show that each layer once constituted the upper surface, no matter to what depth it may now be below it. They show that the highest mountains have once been the ocean's bottom, and that, too, for a long time, since their sides are filled with corals, crinoids, shells, and other organisms, that could have grown only in the sea.

59. In respect to fossils how are the rocks divided?

ANS.—Into Fossiliferous, and Non-Fossiliferous, The first comprises all the rocks that contain fossils; that is, all the stratified rocks, except gneiss, mica slate, hornblende, etc. The second, all the unstratified rocks, and such of the stratified as were formed before life was introduced upon our planet.

60. Define Petrification.

ANS.—It consists in the infiltration of stony matter into the pores of vegetable or animal substances.

61. Name the four great eras.

ANS.—The Eozoic (dawn of life), the Paleozoic (ancient life), the Mesozoic (middle life), and the Cenozoic (recent life). These names indicate the successive stages in the development of life on the globe.

NOTE.—The Eozoic era was, until lately, universally known as the *Azoic* (without life). There was doubtless such a period when the heated earth, swept by a blowing ocean, was destitute of inhabitants. Recent discoveries, however, seem to indicate that the lowest of the so-called Azoic rocks which have actually been observed exhibit proof of the existence of life, and the name Eozoic has therefore been substituted. Dana does not accept this



conclusion, and in his manual of Geology (pp. 149-157) uses the term *Archæan* (from the Greek for *beginning*.) There is no doubt that the Eozoic was preceded by an Azoic era, but it yet remains for the rocks of either period to be fully identified.

## 62. What are some of the periods?

Ans.—Steele's classification is Laurentian, Huronian, etc.; Dana's, Primordial, Canadian, and Trenton, (*Lower Silurian*); Niagara and Salina, (*Upper Silurian*); Upper Helderberg, Hamilton, Chemung, and Catskill (*Devonian*).

## 63. What kinds of rocks belong to the Eozoic?

Ans.—The crystalline or metamorphic, as granite, gneiss, marble, quartzite, limestone, etc. Beds of graphite, porphyry, soapstone and slates, also occur. All were doubtless deposited as sedimentary strata, and afterward crystallized. The Eozoic was emphatically the era of iron. The iron ore beds of the Adirondacks in northern New York, the Iron mountains of Missouri, the Marquette mines of Lake Superior, and many others, date from this time.

Query.—What are incrustations? How is the gradual elevation of Norway and Sweden proved? What are the teachings of the igneous rocks? Define a Synclinatorium. Ans: A finished mountain range. What are Plutonic rocks?

## 64. What are the oldest mountains upon the Western Continent?

Ans.—A range of hills called the Laurentian located between New York and Canada.

## 65. Name the divisions of Paleozoic Time.

Ans. 1. The Silurian Age, or Age of Invertebrates. 2.

The Devonian Age, or Age of Fishes. 3. The Carboniferous Age, or Age of Coal Plants.

NOTE.—Sir Roderick Murchison first proposed the name of Silurian when he had studied and classified them in that part of Wales and some of the contiguous counties of England which once constituted the kingdom of the Silures, a tribe of ancient Britons.

66. What is *Lingula sandstone*?

ANS.—The older sandstone abounds in many places in a shell smaller, in general, than a finger-nail, related to the modern *Lingula*. It is the shell of a mollusk of the tribe of Brachiopods. When alive, it stood on a stem. These shells are so characteristic of the beds in many regions as to have suggested the name *Lingula flags*, or *Lingula sandstone*.

67. From what is the Potsdam period named?

ANS.—From Potsdam, a town in northern New York, where the rock is exposed in the quarries to a thickness of 70 feet. The formation is well developed in Pennsylvania and can be traced westward to the Black Hills of Dakota, and southward along the Appalachian range from Vermont to Alabama and is known in Texas.

68. What is the kind of rock?

ANS.—It varies much throughout this wide extent. At Potsdam it is a coarse, hard sandstone; at Malone, a friable one; as Keeseville, a quartzite; and at other localities, a fine white sand, fit for glass-making.

69. What is an example of an "Inverted Volcano?"

ANS.—The Sculptured Rocks of Lake Superior. The

strata of the Pillared Rocks form a wall 50 to 100 feet high, and line the shore for a distance of five miles. Their marked hues and fantastic shapes excite the imagination of every beholder. Here is "Miner's Castle," with its turrets and bastions; there "Sail Rock," a ship with sails full spread; and yonder "The Amphitheatre," with its symmetrical curves. A closer inspection only reveals more curious details and resemblances.

70. What are the fossils of the Hudson Period?

Ans.—In the limestone regions, corals, shells, trilobites, etc., are abundant. In the shales, however, they are sparingly distributed, being mostly those which flourish in muddy waters. The graptolites (*rock-writing*) of the kingdom of Radiates are striking fossils. They are merely a delicate, plume-like tracery upon the rock. They have therefore been poetically styled *seapens*. They delighted in foul, as the corals in clear water, and must have thickly covered the muddy bottom of the shallow sea with their fragile, mossy branches. They are commonly found in scattered fragments.

Query.—What is the *Oneida Conglomerate*? the *Shawangunk grit*? When was the Cincinnati period? What is a trilobite? Describe the *fucoids*. What is the "dye-stone"?

71. What is the *spirifer arenosus*?

Ans.—A brachiopod which is the most common fossil of the Oriskany Period. The rock, a light, rough sandstone, is often almost entirely made of these characteristic shells or of their casts.

NOTE.—The fossils, constituting a kind of life-thermometer indicate that the climate of the Silurian was uniform.

72. How did the Devonian Age derive its name?

Ans.—It was so named by Sedgwick and Murchison, from Devonshire, England, where it occurs. It is often styled the Old Red Sandstone, from the prevalent color of the rock, and has been immortalized by Hugh Miller under that name. On this continent its color and character are very different, although it is similar in its dominant fossils.

NOTE.—By far the greater number of the Old Red Sandstone fishes belong to a sub-order of Ganoids instituted by Huxley in 1861, and for which he has proposed the name of *Crossopterygidae*, abridged from *Κροσσωτός* (fringe), and *πτερυξ* (a fin): i. e., crossotos and pteryx, or the fringe-finned, in consideration of the peculiar manner in which the fin-rays of the paired fins are arranged so as to form a fringe around a central lobe, as in the *Polypterus*, a genus of which there are several species now inhabiting the Nile and other African rivers.

73. What was the origin of Old Red Sandstone?

Ans.—Many circumstances that favor the theory of its *fresh-water origin* are confirmed by finding it in Lake Superior and the inland Canadian seas of fresh water, and in the Mississippi and African rivers are those fish which have the nearest affinity to the fossil forms of this ancient formation.

74. What did the early fishes prophesy?

Ans.—Not only the reptiles which were to come, but also the birds and even mammals. Though the ancient types have become obsolete, and have been replaced by modern ones, as Agassiz happily remarks, a few old-fashioned individuals have been left behind to give the key to the history of the race.

*Query.*—What does the gar-pike explain? the nautilus? Locate Oriskany Falls. What is meant by the Corniferous Period?

75. What are the Cyprinodons?

*Ans.*—The sightless fish who grope in the absolute darkness of the waters of the Mammoth Cave; they are of a milk-white color.

76. How was the Carboniferous Period inaugurated?

*Ans.*—By the formation of a conglomerate sandstone the Millstone Grit whose ledges often separate into huge blocks. Where a portion has been swept away during subsequent geologic changes, the remains present a striking resemblance to the streets and blocks of a ruined city. Several of these so-called "Rock cities" are situated in southwestern New York.

*NOTE.*—In the district called the Joggins, in Nova Scotia, the coal formation is 14,000 feet thick, and contains seventy-six beds or seams of coal; only part of these, however, are of workable thickness. The "mammoth vein" exposed to view at Wilkesbarre, and worked at Carbondale, Mauch Chunk, Shamokin, etc., is 29½ feet thick. The Pittsburg seam is 8 feet thick, and may be traced for a long distance as a conspicuous black band along the high banks of the Monongahela.

77. Describe the two kinds of mineral coal.

*Ans.*—*Anthracite* is mostly without bitumen, very hard, with a high lustre, often iridescent, and burns with a pale blue flame. *Bituminous* coal abounds with bitumen, is softer than anthracite, with little lustre, and burns with a bright flame. It appears in many varieties, one of which is the well-known *cannel* coal.

78. What is said of ferns?



ANS.—Ferns which to-day creep at our feet, then towered into stately trees, with trunks a foot and a half in diameter. They are abundant fossils, and doubtless contributed most to the formation of coal.

### 79. Of what origin are coal-beds?

ANS.—Vegetable origin. This might be inferred from the fact that coal is mainly Carbon, which substance forms one-fourth to one-half of all the vegetation on the globe. But, prepared in very thin slices, coal shows its vegetable structure under the microscope, and often even to the naked eye.

### 80. How did this vegetation accumulate?

ANS.—By the slow growth of plants, just as peat is now forming in peat-bogs. Our peat-bogs are only incipient coal-beds, and need only to be submerged, and covered with great depths of strata, in order to become genuine coal.

NOTE.—In a coal mine near the Bay of Fundy, in the stumps of two *sigillariae*, there have been found the remains of several small reptiles bearing frog-like and lizard-like forms, a centipede, and the shells of a land snail. These little creatures had probably crept into the hollow trees for shelter, and were overtaken by the convulsions which overwhelmed them. Several true reptiles have since been identified.

Query.—What is a “petrified butterfly”? What are the characteristic fossils of the carboniferous era? Where are the Hellderberg Mts.? Give a scenic description of the Silurian Age.

### 81. What are the divisions of Mesozoic Time?

ANS.—The Reptilian Age includes three periods: 1. Triassic: named from the Latin *tria*, *three*, in allusion to the fact that the rocks of the period in Germany consist of

three separate groups of strata. This is a local sub-division, however. This period is sometimes termed the New Red Sandstone, to distinguish it from the Old Red Sandstone of the Devonian. 2. Jurassic: named from the Jura Mountains, situated on the eastern border of France, between France and Switzerland, where rocks of the period occur. 3. Cretaceous: named from the Latin *creta*, *chalk*, the chalk-beds of Britain and Europe being included in the Cretaceous formation.

NOTE.—The American rocks of the Triassic period have not yet been separated from those of the Jurassic, except in the region west of the Mississippi. The popular “free-stone” of Portland, Conn., and Newark, N. J., is a Triassic rock. Near Richmond, Va., and Deep River, N. C., are valuable coal beds in the rocks of this era. At the west this formation consists of beds of brick-red marl and sandstone. The celebrated Solenhofen imestone, so much used in lithography, is out of the Jurassic Period.

82. What animal had the general contour of a dolphin, the snout of a porpoise, the head of a lizard, the jaws and teeth of a crocodile, the vertebrae of a fish, the sternal arch of the water-mole, the paddles of a whale, and the trunk and tail of a quadruped?

Ans.—The *Ichthyosaur* (fish-lizard).

83. What are the gold-bearing rocks of California?

Ans.—Mainly Jurassic or Triassic metamorphic sandstones with interstratified quartz containing gold. Where the quartz veins have come to the surface and weathered, the particles of gold have been washed out, and thus formed auriferous sands.

## 84. Cenozoic Time covers what two ages?

Ans.—The Tertiary Age, or Age of Mammals; The Quarternary, or Age of Man. Steele makes but one division, including the two periods *Tertiary* and *Post-Tertiary*.

NOTE.—Lyell makes the divisions of the Tertiary Period to be Eocene (from the Greek *ἠώς*, *dawn*, and *Καίνος*, *recent*): species nearly all extinct. Miocene (from *Μείων*, *less*, and *Καίνος*): less than half the species living. Pliocene (from *πλεῖων*, *more*, and *Καίνος*): more than half the species living. On this continent, however, these terms do not apply, and an American classification has been adopted, known as the Lignite, Alabama, Yorktown (Va.) and Sumter (S. C.) Epochs.

## 85. What is said of the rocks of this era?

Ans.—The Tertiary rocks are generally but little consolidated; they consist mostly of compacted sand, pebbles, clay, earth that was once the mud of the sea-bottom or of estuaries, mixed often with shells, or are such kinds of deposits as now form along sea-shores and in shallow bays and estuaries, or in shallow waters off a coast. There are also limestones made of shells and others of corals, resembling the reef-rock of coral seas.

## 86. What is said of the plants?

Ans.—The abundance of vegetable remains proves the land to have been covered with an exuberant flora. Leaves of oak, maple, poplar, hickory, cinnamon, fig, palm and pine are abundant.

Query.—When did the seasons commence? What animal is a curious intermediate link between birds and reptiles? When did the region of gigantic reptiles terminate? What were Dinosaurs? Describe the Plesiosaur. What frog-like quadruped often attained the size of an ox?

87. What are the three epochs of the Post-Tertiary?

Ans.—Glacial (*Drift or Boulder Period*), Champlain, and Terrace. The last treats of the elevation of the continent, its oscillations, and the existence of sea beaches far above (1,200 feet) the ocean level.

NOTE.—The highest mountains of every country are the newest or last elevated. The Alps are younger than the mountains of Scandinavia; the Rocky mountains younger than the Alleghanies, and the latter younger than the White Mountains of New Hampshire.

88. What is the Ohio Elephant?

Ans.—The Mastodon, which has a general resemblance to the modern elephant. A single tooth, however, is sufficient to distinguish its remains. The grinding surface of a mastodon's tooth is covered with conical projections—whence the name of the animal—while that of the elephant is flat.

89. What was the Dinotherium?

Ans.—A gigantic mammal whose remains occur in Bavaria, Austria, and France. This animal was about 18 feet in length, and particularly remarkable on account of two tusks which turned downwards, enabling it to tear up the roots of aquatic plants. It probably lived about the water, like the hippopotamus of the present time.

90. What are the epochs of the Stone Age?

Ans.—1. That of extinct animals such as the mammoth and cave-bear. 2. Migrated existing animals (*Reindeer*). 3. The Polished Stone. To the Metal Age belong the Bronze Epoch and the Iron Epoch. These are the classi-

fications, according to the fossil remains, of the life of the pre-historic man.

91. How would you teach a class the elements of Geology and Mineralogy?

Ans.—Illustrated by Class-Drill: T.=teacher, P.=pupil.

P. What is feldspar?

T. Minerals which break naturally into forms, shaped like a bar of soap, and having smooth faces, are frequently called *spars*, and feldspar, from its yellow color and shape, at a little distance, might be taken for a bar of common yellow soap. Does any one know where it is obtained?

P. From the quarries in Topsham, Maine.

T. Yes; and what is a quarry?

P. A place where men get out stone by drilling and blasting.

T. That is correct. Now feldspar is common almost everywhere and for that reason is called the spar of a *feld*, or field. Thus we derived the name *feldspar*.

P. Does it ever come as large as a bar of soap? All that I've seen has been in little pieces in granite.

T. From some quarries pieces of feldspar are blasted from the ledge as large as a barrel, and the ledge at Topsham, (itself of pure feldspar), is as large, at least, as a block of a dozen houses.

P. Is feldspar always red in color?

T. No. Sometimes it is yellow and frequently it is of a fine green color, and then it is called *Amazon-stone*.

Continued *ad libitum*.

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### Puzzlers.

What is Zaffre? Smalt? Describe "german silver," and "mosaic gold." What metal is the only liquid in all ordi-



nary temperatures? What are "faults," and what do they retard? Are you familiar with the writings of DeSaussure, Venetz, Charpentier, Agassiz, and Guyot? Where is the "Devil's Pulpit?" From what is glass made? What is *staurotide*? Agate is a variety of what? What is the common name of mica? Ans. Isinglass. Upon what kind of rocks are the Scottish fortresses built? Where is the Glacier of Zermath? What is the meaning of the term Amygdaloid? Can you give the true outlines of the *oceanic depression*? What is the geological formation of Mt. Tom and Mt. Holyoke? Where is Titan's Pier? Where are "brown-stone fronts" quarried? What are cuttle-fish bones? Describe *coprolites*. When was the Ichthyosaur discovered? What are Oriskany beds? Of what does the Lower Helderberg group consist? Where is the formation of the Hudson Period to be seen? Give an account of Dr. Hawkins's dinner party. What is *cephalization*? How does the geological record of the Eozoic age agree with the Mosaic account? What are *mesas*? Where is the "Valley of Death?" What is the meaning of *rhizopod*? Ans. "Root-footed." What is the medial Moraine? Describe the Ammonite. What is meant by "hydraulic lime?" What is *chrysoberyl*? *Wavellite*?







# PHYSICS.





# PHYSICS.

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## 1. Define Natural Philosophy and Chemistry.

Ans.—Natural Philosophy, or Physics, has for its objects the investigation of the properties of all natural bodies, and of their mutual action on each other. It is the science of causes and principles.

Chemistry is that department of science whose object is to ascertain the proportions in which the elements of matter combine, and the modes of separating them when united; and to inquire into the laws which effect, and into the powers which preside over their union. The former treats of phenomena in which there is a physical change in matter; the latter studies the causes and effects of chemical change.

Query.—How are natural laws discovered? What is Science?

## 2. Explain the difference between a physical and a chemical change.

Ans.—The first *may occur* without the loss of those specific properties by which we recognize matter; and the second *can not occur* without the loss of such peculiarities. The first does not destroy the molecule; the second forms new molecules.

Example.—The power of gunpowder to explode is a chemical property; the tendency of iron to unite with the oxygen of the air, forming a rust, is a chemical change.

*Query.*—Is the burning of a feather a physical or a chemical change? The union of copper and zinc to form brass? The dissolving of sugar? The freezing of water? The formation of steam? The making of bread?

### 3. What is matter?

*Ans.*—Whatever occupies space and prevents other things from occupying the same space.

*NOTE.*—A distinct portion of matter is termed a *body*. A particular kind is called a *substance*.

*Query.*—Is a shadow, gold, or air, matter? What change is matter constantly undergoing?

### 4. Classify the substances.

*Ans.*—Elementary substances, or elements (63 in number), are those which contain only a single kind of matter. The union of two or more elements forms a compound substance.

### 5. What are the three conditions of matter?

*Ans.*—Solids, liquids, and gases.

*Query.*—Which are the most compressible, solids or liquids? liquids or gases?

### 6. How do we know that solid matter contains pores?

*Ans.*—Because many solids are permeable to liquids. (By a powerful pressure upon water it can be forced through a plate of gold.) Because all matter is compressible, and because all matter is contracted by cold.

*NOTE.*—Solids are bodies in which the force of molecular attraction is greater than that of repulsion. Liquids are bodies in which the forces of attraction and repulsion are equal to each other, and in Gases the force of repulsion is greater than that of

attraction. The molecules of matter are kept in their relative positions by the force of molecular attraction and repulsion. The cause of the former is unknown. The latter is caused by heat.

Query.—What are fluids? What are æriform bodies?

7. What is the difference between *mobile* and *viscid* fluids?

Ans.—In some liquids the molecules move more freely over one another than in others. The first are called mobile, as alcohol; the second viscid, as tar.

Query.—Is oil, molasses, ether, milk, mobile or viscid?

8. What is vaporization?

Ans.—When by the action of heat, liquids become changed to gases or vapors.

NOTE.—Water is a *solid* when reduced below the freezing point, and by the action of heat it becomes æriform. *Condensation*, the opposite of this, is when the vapor becomes a liquid again by loss of heat.

Query.—What is liquefaction? Why is salt used in freezing ice cream? On the contrary it is used in thawing out a pump.

9. What is force?

Ans.—If a body were left wholly to itself it would either continue at rest, or it would move uniformly in a straight line. Any cause which changes or tends to change either of these conditions is a *force*.

Query.—What are the various kinds of force? What is energy? What is meant by a force of 10 pounds? What is kinetic energy? What are Newton's Laws of Motion? From what does the first law result?

10. What is necessary in order to ascertain the effect produced by any force?

Ans.—Three things. The point of application, the direction and the velocity.

### 11. Define Mass, Velocity, and Momentum.

Ans.—Mass is an abbreviation for quantity of matter; velocity the distance through which a moving body passes in a given time; momentum the quantity of motion it possesses, which is equal to the mass multiplied by its velocity.

Ex.—A body weighing 4,000 lbs., traveling at the rate of 6 feet a second, its momentum is 24,000 lbs. Formula:  $4,000 (ms) \times 6 (v) = 24,000 (mom)$ .

Query.—What is the velocity of a snail? a man walking? a railway train?

### 12. When a body moves through equal distances in successive seconds its motion is said to be what?

Ans.—Uniform; the opposite of this is Varied. The last is of two kinds: uniformly accelerated and uniformly retarded.

Query.—What is rectilinear, curvilinear and rotary motion? absolute and relative?

### 13. Explain the difference between the common and scientific use of the term phenomena.

Ans.—As commonly used it means something unusual or strange; as used in science it means anything which happens naturally.

Ex.—The falling of a rain-drop. The budding of a leaf.

Query.—What is cause and effect?

14. What do we mean by the properties of a body? Name and define them.

Ans.—Those peculiarities, or qualities, which enable us to recognize it. The properties are *general* or *specific*. General properties are those which belong in common to all matter, as Magnitude (or Extension), Impenetrability, Divisibility, Mobility, Expansibility, Contractibility, Indestructibility, Porosity, and Inertia, or passiveness. Some authorities include Gravitation. Specific are those which belong only to certain substances; as Brittleness, Hardness, Elasticity, Malleability, Ductility, Tenacity and Crystalline form.

For definitions, see Dictionary.

Query.—What two serve to define matter? Which is the most malleable of metals? Is copper malleable? What three dimensions must matter have?

NOTE.—Tenacity. There is something very interesting, but not altogether as yet understood, in the behavior and strength of iron and steel when loaded. It is all very well to institute certain tests to find the number of lbs. it requires to break a piece having a sectional area of one square inch, and from this pronounce what is the strength of the iron; because, with our present knowledge and appliances it is all we can do, and a test of some kind is of course imperative. It is a curious fact, however, that the strength of a piece of iron or steel varies according to the manner in which the load is applied. If a metal receives its load suddenly, it will break under a less weight than if the load comes on slowly and gradually increases; and the difference is not a minute one either, for it is as great as 20 per cent. under the two extremes of conditions.

15. What is the difference between an atom and a molecule?

Ans.—The word atom means that which cannot be cut, or indivisible. Practically there is no limit to the divisibility of matter, but philosophers hold that there is in theory.



The Atomic Theory, originated by Democritus, is that the smallest particle of matter we can see is composed of still smaller particles or molecules, each possessing the specific properties of the substance to which it belongs. A molecule (tiny mass) is a group of atoms held together by chemical force, and is the smallest particle of a substance which can exist by itself.

*Query.*—What is a particle? Can atoms or molecules be obtained by artificial means? *Ans.* No.

16. The resistance to motion is produced how?

*Ans.*—In the case of air and water it is a fluid resistance. In other bodies it is caused by friction, and this is produced by the irregularities of the surfaces in contact, and by the attraction which bodies have for each other.

*Query.*—What is friction? Name the classes.

17. What is equilibrium?

*Ans.*—Rest. When two forces of equal intensity act in opposite directions, they will be in equilibrium and the body at rest. There are three forms: stable, unstable, and neutral, according as the point of support in a body is above, below or at the centre of gravity.

*Query.*—When a person slips on one side what does he do and why?

18. Describe the parallelogram of forces.

*Ans.*—In short, the line (diagonal of a parallelogram) representing the direction and intensity of the force produced by the combined effect of the two components is the resultant. Mathematically a demonstration of the Pythagorean theorem.

*Query.*—What is Centrifugal and Centripetal force? Can a single force cause motion in a circle? The angle of incidence equals what? Demonstrate.

19. The mechanical powers are modifications of what?

Ans.—The lever and the inclined plane. The first includes both the wheel and axle, and the pulley. The second, the screw and the wedge.

20. What is a lever of the first, second and third class?

Ans.—First, when the fulcrum is between the power and the weight; second, when the weight is between the power and the fulcrum; third, when the power is between the fulcrum and the weight.

*Query.*—In which of these three classes is a pair of scissors, sugar-tongs, a wheelbarrow, a balance, a door opened by the hand applied to the knob, and a crow-bar in moving a stump while resting upon a stone? Why is perpetual motion impracticable?

21. “*No energy is gained by a machine.*” Explain then how we can raise a weight of 1000 lbs. by using a force of only 100 lbs.

Ans.—Suppose a man can lift only 100 lbs., and by using the lever he can raise these 1000 lbs.; but to raise these 1000 lbs. through one foot he would be required to continue exerting a force of 100 lbs. through ten feet, and this would clearly be the same as if he divided the 1000 lbs. into ten separate parcels of 100 lbs. each, and for ten successive times exerted his strength of 100 lbs. through a single foot.

22. How can the power of the screw be estimated?

Ans.—Any force acting to turn a screw will cause the screw to move with a force as much greater than its own as the circumference of the circle through which it moves is greater than the distance between any two contiguous threads. This, like all general laws, is modified by friction.

Ex.—If the power act on a 'screw' through a circumference of 6 inches, and the distance between any two contiguous threads be  $\frac{1}{8}$  of an inch, then one lb. applied at the head would advance the power of the screw  $6 \div \frac{1}{8}$ , or 30 lbs.

23. What is Sir Isaac Newton's Law of Universal Gravitation? Discovered in 1682.

Ans.—Every particle of matter in the universe attracts every other particle of matter with a force that is directly proportional to the mass, and inversely proportional to the square of the distance.

Query.—What simple event in 1666 led to this discovery? Ans. An apple falling from a tree.

24. What is meant by saying one thing is inversely proportional to another?

Ans.—That it increases or decreases in the same ratio that the other decreases or increases.

25. The attractive force is inversely proportional to the square of the distance. Illustrate.

Ans.—The centre of the earth is the centre of gravity. A body on the earth's surface is 4000 miles from the cen-

tre. If a lb. be carried four thousand miles above the earth's surface, it would weigh but a quarter of a lb., since as its distance from the earth's centre is doubled, the earth's attraction for it is diminished one-fourth.

NOTE.—1000 miles below the earth's surface, a body would gain  $\frac{1}{4}$  its weight. The fact is, however, the density of the earth increases so much toward the centre that for "seven-tenths of the distance the force of gravity actually becomes stronger than on the surface." A body at the centre of the earth would have no weight, since the attraction would be the same in all directions. As the earth is bulged out at the equator, a body when at the equator is farther from the earth's centre than when at the poles. The same body, therefore, would weigh more at the poles than at the equator; 194 lbs. at the equator would weigh 195 lbs. at the poles. A standard lb. is 22 grains lighter at the equator than in London.

*Query.*—What would a lb. weigh 12,000 miles above the earth's surface?

*Solution.*—The distance from centre of earth is 12,000 + 4,000 = 16,000 miles; then  $16,000^2 : 4,000^2 :: 1 \text{ lb.} : x = \frac{1}{16} \text{ lb.}$

26. Who discovered the 5 laws of falling bodies.

Ans.—Galileo, in 1590.

*Query.*—What is the velocity of a falling body? Which will fall the faster, a lb. of iron or a lb. of cork? A ball projected vertically upward returns in 16 seconds to the place of projection; How far did it ascend?

27. The Pendulum. Define oscillation, and time and amplitude of oscillation.

Ans.—Each complete swing is called an arc, or oscillation. The line which marks the distance the pendulum has moved from a vertical position is called the amplitude of the oscillation.

*Query.*—What are the 3 laws of vibration? How long is a pendulum that beats once a second? once in three seconds? Does a clock gain or lose time in winter? What are the forms of the compound pendulum?

*NOTE.*—Galileo was the first to think of turning the pendulum to a practical use. Sitting in the cathedral at Pisa (1581) he noticed that the vibrations of an immense chandelier suspended from its lofty ceiling were *isochronous*. The sun-dial was undoubtedly the first device for keeping time, followed by the *clepsydra*, a vessel containing water which slowly escaped into a dish below, in which was a float that by its height indicated the lapse of time; or scales on the side of the vessel that showed the number of hours it took the liquid to reach them in its descent. Even Alfred the Great, to tell the passing hours, used wax candles 12 inches long and of uniform thickness, 6 of which lasted a day. The hour-glass, a subsequent form of time-keeper, is at present an article of elegant novelty.

28. How can we determine, by means of the pendulum, the variations of the intensity of gravity at different parts of the earth?

*Ans.*—The pendulum will oscillate more rapidly at the poles (13 vibrations more) than at the equator, because the force of gravity is greater there: that is, it is nearer the earth's centre.

29. Why do not rain-drops strike with a force proportional to the laws of falling bodies?

*Ans.*—Because they are so small that the resistance of the air nearly destroys their velocity. But for this wise provision, a shower of them would be as fatal as one of minie-rifle bullets.

30. What is the difference between cohesion and adhesion?



ANS.—Cohesion is that form of molecular attraction that holds together molecules of the same kind of matter; adhesion holds together different kinds.

### 31. What is capillarity?

ANS.—The elevation or depression of liquids in tubes not exceeding  $\frac{1}{15}$  of an inch in diameter.

The oil rising in the wick; the towel becoming wet with the lower part only dipped into water; blotting paper drinking up ink, are familiar examples of capillarity.

Query.—Why should a liquid be elevated in a capillary tube when it wets the tube, or depressed when it does not?

NOTE.—If a tube capable of raising water four inches be broken off at three, there will be no overflow, as might be expected, but it will be supplied as fast as evaporation takes place.

### 32. What is Osmose—Endosmose and Exosmose?

ANS.—It is the unequal mixing of two liquids through a thin, porous substance or wall separating them. The cause is not fully understood.

NOTE.—Endosmose and exosmose enter largely into the operations of nature. They cause the ascent and descent of sap in trees and vines.

### 33. Define hydrodynamics.

ANS.—Dynamics means power, and treats of the use of force.

*Hydrodynamics* treats of the conditions of rest and motion in fluid bodies. It includes *Hydrostatics*, which treats of liquids at rest; *Hydraulics*, which treats of liquids in motion, and *Pneumatics*, which treats of gases either at rest or in motion.

*Query.*—What is the hydrostatic press? The weight of a cubic foot of water is 62.3 lbs. How much does a cubic inch weigh?

### 34. What is the principle of Archimedes?

*Ans.*—Bodies, when immersed in a liquid, lose as much of their weight as the weight of the liquid they displace.  
230 B. C.

*NOTE.*—The law of hydrostatics is that water always finds its level. Engineers carry water across a river in pipes through the valley, or under the bed of a river, knowing that it will rise on the opposite side to its level. Artesian wells, so called from the province of Artois in France, where they were first introduced in Europe, though known to the Chinese for centuries, represent this principle.

### 35. Define Specific Gravity, or relative weight.

*Ans.*—The weight of a substance compared with that of the same bulk of another substance. It is really the method of finding the density of a body.

*Rule.*—The weight of a body in air divided by the weight of an equal volume of water.

Distilled water, at a temperature of 60°, is taken as a standard for solids and liquids, and air for gases. A cubic inch of carbonic-acid gas weighs 1.52 times as much as the same volume of air; hence its specific gravity is 1.52.

*Query.*—Why do the oily particles of soup float on the top? Why does smoke rise? How do fish sink at pleasure?

*NOTE.*—Maskelyne, in 1774, found the attraction of Mt. Schi-hallion to be 12'. By comparing this force with that of the earth, the specific gravity of the mountain being known, the specific gravity of the earth was estimated to be five times that of water. Later investigations make it 5.67.

### 36. What is a head?

Ans.—The vertical distance from the middle of the orifice to the surface of the liquid enclosed in a vessel. The amount of liquid which flows out of an orifice in a given time is called a *flow*.

37. Give the rule for calculating the velocity of escape of a liquid from an orifice.

Ans.—It is equal to 8 times the square root of the head.

Ex.—If an orifice was four feet below the surface of a liquid, then the velocity of escape would be  $8 \times \sqrt{4} = 8 \times 2 = 16$  feet per second.

38. How are waves produced?

Ans.—By the friction of the wind against the surface of the water.

39. What will give motion to water?

Ans.—A fall of only 3 inches a mile is sufficient to give motion to water, and produce as many miles per hour. A fall of 3 feet per mile makes a mountain torrent, The Ganges descends but 800 feet in 1,800 miles, requiring a month to move down this inclined plane.

40. What are the principal forms of water-wheels?

Ans.—The under-shot, the over-shot, the breast-wheel and the turbine. Define them.

41. How was the pressure of the atmosphere discovered?

Ans.—It was the result of a celebrated experiment performed by Torricelli, about the middle of the 17th century.

*Query.*—What is the pressure (at the sea-level) of the air to the square inch? What is the depth of the atmosphere? *Ans.* From 50 to 500 miles. What causes the rise of water in a vacuum?

*NOTE.*—The Barometer, invented by Pascal, is used to indicate the weather, and to measure the height of mountains. The Air-Pump was invented by Otto Guericke, burgomaster of Magdeburg, Germany.

The density of the air rapidly diminishes as we ascend. At the height of  $3\frac{1}{2}$  miles, it is but one-half that at the sea-level. At 40 miles the atmosphere is as rare as in the vacuum of an air-pump. Among the Andes, the Indians are subject to a malady called *veta*, which is caused by the rarity of the air.

#### 42. Define Acoustics—the science of sounds.

*Ans.*—Sound is produced by vibrations or wave-like motions of elastic bodies, transmitted through the air by the ear to the brain. The usual velocity of sound in air at the temperature of freezing water is 1120 feet a second. A good ear can distinguish 9 or 10 *distinct* sounds a second, as separate sounds. Sounds travel with different velocities in different media; e. g., about 4 to  $4\frac{1}{2}$  times as fast in water, and through iron from  $10\frac{1}{2}$  to 15 times as fast as in air.

*Query.*—What acoustic properties has your school-room? A bombardment was heard 40 miles. How many seconds transpired before the report of a cannon was heard? In how many senses is the word sound used?

#### 43. What is resonance?

*Ans.*—The reflection of sound-waves (by the same law as that of reflected motion—the angle of incidence equals the angle of reflection,) from the ceiling and walls of a room, or of any confined space.

*NOTE.*—The human ear is limited to continuous or musical sounds produced between 16 and 33,000 vibrations a second. Between 10 and 16 vibrations a second cause a confused hum or buzz

below the lowest musical note. In the same medium high or low sounds are ordinarily conducted with equal velocity. A fundamental note is produced by a given number of vibrations, and its octave higher by double that number of vibrations in a second.

*Query.*—Is your voice sonorous? What is the minimum distance from a reflecting surface at which an echo is possible? *Reasoning.*—An echo is a sound repeated by reflection. The ear can hear ten sounds a second. The velocity of sound is 1120 feet per second. Therefore  $1120 \div 10 = 112$ , the number of feet the sound must traverse. But it goes to the reflector and *returns*; therefore,  $112 \div 2 = 56$  feet, Ans. Why is there no discord in a band or choir at a distance? How many octaves can the ear comprehend? What is a noise? What kind of vibrations produce music? At what distance can people in the Arctic region converse with each other, and why?

44. Why are sounds more distinct at night than by day?

Ans.—The air at night is more *homogeneous*; therefore sounds are heard more clearly and farther than in the day time.

*Query.*—At what place will an echo return 17 syllables by day and 20 by night?

45. How can two sounds produce silence?

If two sounds meet in exactly opposite phases, and the two forces are equal, they balance each other, and silence ensues. A sound added to a sound will produce silence. Likewise two motions may produce rest; two lights may cause darkness; two heats may produce cold.

*Query.*—What are the divisions of wind instruments? What is a Siren?

46. Define heat—the science of Pyronomics.

Ans.—Heat is motion. The molecules of a body are in constant motion.



When we increase the rapidity of this movement, we heat the body. When we decrease it, we cool the body.

*Query.*—What is the *caloric theory*? What is sensible heat?

#### 47. Give the classes of heat?

*Ans.*—*Luminous* heat is that which radiates from a luminous body (red-hot iron); and that radiated from a non-luminous source is termed *obscure* heat. Luminous heat almost always contains in addition obscure heat, *Cold* is a relative term indicating the partial absence of heat.

*Latent* heat is that which does not increase the temperature, and cannot, therefore, be detected by the thermometer.

*Query.*—What latent heat does water in the form of ice gain at 32° to become a liquid? *Ans.* 142°. Describe the Calorimeter. What is meant by the heat of liquefaction?

*NOTE.*—Gases and vapors differ but slightly. The first retain their form at the ordinary temperature and pressure; *Ex.*, air. The second are readily condensed, and at the ordinary temperature appear as solids or liquids; *Ex.*, steam.

#### 48. What is the law of radiant heat?

*Ans.*—Radiant heat diminishes in intensity as the square of the distance from the radiating body increases.

*Ex.*—A person standing within two feet of the fire receives four times as much heat as one standing four feet from it.

*Query.*—The planet Neptune is about thirty times as far from the sun as the earth is; how does its solar heat compare with ours?

#### 49. How is heat diffused from one body to another?

Ans.—In three ways. It is distributed through solids by conduction; through liquids and gases by convection and radiation. Like light, heat may be reflected, refracted, and polarized.

Query.—Which has the greatest conductivity, iron or copper? What is the meaning of “*polarized*”?

## 50. What is meant by absorption?

Ans.—When ether-waves strike against the surface of a body, those which are not reflected pass into the body. If, in passing through the body, the waves give up their motion to the molecules, the body becomes hot, and the heat is absorbed. The reflection of heat is like the reflection of sound.

NOTE.—A good absorber is also a good radiator, but a good reflector can be neither.

Query.—Which is snow? Is white or black the better radiator?

## 51. What is diathermancy?

Ans.—When the ether-waves pass through a body without giving motion to the molecules, that is, without heating it, the body is *diathermanous*, or transparent. When it will not let the heat pass through it, it is *athermanous*, or opaque to heat.

Query.—Which is diathermanous, air or iron? dry air or watery vapor?

NOTE.—Heat is the great antagonist of cohesion. Force can not be destroyed, for if it is changed in one form, it re-appears in another without loss.

## 52. Why does heat expand and cold contract?

Ans.—By the addition of heat, the molecules are urged into swifter motion, and, therefore pushed further apart, increasing the size of the body.

**NOTE.**—If heat be applied to a liquid, the temperature rises until the boiling point is reached, when it stops. The expansion, however, continues until the motion is so violent as to overcome the cohesive force and to throw off particles of the liquid. This is known as the theory of vaporization. Describe the theory of boiling.

**53. How is heat obtained?**

**ANS.**—The sun is the principal source of heat. It is obtained by chemical and mechanical means.

**Query.**—By which method do we derive heat from burning coal?

**54. What is specific heat?**

**ANS.**—The relative amount of heat which a body receives in reaching a given temperature. Taking water as a standard, the specific heat of iron is  $\frac{1}{9}$  and of mercury only  $\frac{1}{35}$ .

**Query.**—As it takes twice as long to raise water to a given temperature as it does oil, what is the specific heat of oil?

**55. Describe the Steam Engine.**

**ANS.**—The first idea of the steam-engine was suggested by the Marquis of Worcester, in his "Century of Inventions," in 1663, in describing an apparatus consisting of steam boilers, which worked alternately, and of pipes conveying steam from them to a vessel in which its pressure operated to force water upward. Other experiments were made from time to time, until in 1705 Thomas Newcome, John Cawley, and Thomas Savery patented the first steam-engine really deserving the name. It consisted of a cylinder, containing a piston driven upward by steam from a separate boiler, and forced downward by atmospheric pressure, when the steam below the piston was re-

moved by condensation. The engine was used only for pumping, the pump-rod and piston-rods being attached to opposite ends of a beam, as in ordinary engines. Various improvements were made on this engine until 1763, when James Watt, an instrument maker at the University of Glasgow, in repairing a model engine, began a series of improvements which finally rendered the steam-engine universally applicable. In 1773 he began building the new engine, adding other improvements from year to year. Among his inventions are the separate condenser, the double-acting principle, parallel motion, the regulating action of the governor, and many other improvements. The invention of the crank and fly-wheel is disputed between Watt and Pickard. From that time to the present, progress of invention has suggested many new features in the construction of the steam engine, in its various applications to the needs of different branches of trade.

NOTE.—Steam and some of its properties appear to have been known to the ancients centuries before the Christian era. Hero of Alexandria, who flourished about 200 years B. C., has left us a description of a steam-engine by which machinery could be set in motion.

Query.—What are the two classes of engines? What is meant by Horse-power? What is a Foot-pound? A steam-engine raises a ton weight 286 feet. How many heat units are thus expended.

### 56. What is a Governor?

ANS.—The Governor (an ingenious piece of mechanism) is an apparatus by which the throttle-valve in the steam-pipe is opened and closed, and the supply of steam regulated as the machinery requires. When a machine is going too fast, the balls fly out by centrifugal force and shut off a portion of the steam; when too slowly they fall back, and, opening the valve, let on the steam again.

reach a length often ten-fold that of their host. At maturity they desert the insects at whose expense they have been nourished, and seek the water to lay their eggs and die.

### 76. What are Mollusks?

ANS.—Those animals which have a soft body, enveloped by a muscular skin called a mantle, and in most cases protected by a shell; they are not jointed nor radiated in their internal structure. The shells are the parts of these animals which we oftenest see; for when the animal is dead the soft parts soon disappear, and only the shell remains. Most kinds of mollusks increase by means of eggs: some kinds are viviparous, and some kinds of tunicate mollusks increase by budding. Their blood is white or colorless.

### 77. What are the characteristics of the Cephalopoda?

ANS.—They have muscular tentacles or arms around the mouth; beaked, horny jaws; two large eyes; arms covered with sucking disks; and a bag of ink, with which most species blacken the water to hide from pursuit. To this class belong the "sailors"; the cuttle-fish, which has a spongy, calcareous-mass within its body, known as cuttle-fish bone, and used for canary birds; the beautiful nautilus; and the famous devil-fish.

### 78. What is said of the Muricidæ (rock-shells)?

ANS.—The *Murex* has the aperture of its shell prolonged into a canal. The Shetlanders use this shell for a lamp, inserting the wick in the canal, and filling the body of the shell with oil. From these mollusks the ancients



obtained the costly Syrian dye, the "purple" of Scripture.

79. Why do shells give a murmuring noise when held to the ear?

Ans.—The usual explanation of the "roar of the sea" in shells is that the form of the shell and its polished surface collect and reflect sounds in the air, otherwise imperceptible. Another theory refers the murmur to the circulation of the blood through the capillaries of the fingers holding the shell by which vibrations are magnified. A feeble murmur can be heard, however, when the shell rests on a table, and it is probable that both causes are concerned in the phenomenon.

80. What is the meaning of Echinoderms?

Ans.—Spiny-skinned. They are radiate animals which have a tough skin containing particles of carbonate of lime, or a shell composed of calcareous pieces, which are movable, or fixed together, and covered with tubercles or spines. This sub-kingdom is divided into the four classes of Holothurioidea (*sea-cucumbers*) Echinoidea (*sea-urchins*), Asteroidea (*star-fishes*) and Crinoidea (*feather-stars*).

81. What are the Coelenterates?

Ans.—Radiates having a distinct body-cavity, whose walls consist of an outer layer (*ectoderm*) and an inner layer (*endoderm*). They are all aquatic, and multiply alike by budding, by eggs and by fission. They are usually armed with peculiar stinging filaments. There are the four classes of Ctenophora (*comb-bearers*); Anthoza (*flower-like animals*); Hydroza (*water-dragon animals*)—such as Jelly-fishes and the Portuguese Man-of-War; and Spongida (*sponges*).

accepted, or Undulatory theory is, that light is produced by the undulations of the exceedingly subtile, imponderable medium known as ether, the luminiferous ether.

62. Trace a ray of light through a prism, and show its course in obedience to the laws of refraction.

ANS.—A ray of light falling on a prism (a solid piece of glass, having for its sides three plane surfaces, and for its ends two equal and parallel triangles,) must pass through two of its surfaces. If it strike both of them obliquely, it will be twice refracted; if it strike one surface perpendicularly and the other obliquely, it will be refracted but once.

Query.—What are the laws of reflection and refraction? What is “rotary polarization”?

63. Define Reflection, Refraction, Diffraction, Diffusion.

ANS.—When light falls on the surface of a body, and is thrown off from it at equal and opposite angles to that at which it struck the surface, it is said to be *reflected*. When a ray of light passes from one medium to another of different density, it is *refracted*, or bent out of its course. *Diffraction* is caused by a beam of light passing along the edge of some opaque body. As the waves of ether strike against it, they put in motion another set of waves on the opposite side, which interfere with the first system. When the light which falls on the surface of a body is thrown off from it in all directions, it is said to be *diffused*.

NOTE.—The rainbow is formed by the refraction and reflection of the sunbeam in drops of falling water.

*Query.*—What is chromatic and spherical aberration? We measure the intensity of light by photometers; what are they?

64. What and where is the principal focus of a concave mirror?

*Ans.*—Parallel rays of light falling directly on a concave mirror collect, after reflection, at a point in front of the mirror called the principal focus, which is situated between the centre of the mirror and the centre of the sphere of which the mirror may be conceived to be a part.

*NOTE.*—The three kinds of mirrors or specula are: plane, concave and convex. The general principle of them is that the image is always seen in the direction of the reflected ray as it enters the eye.

*Query.*—What is a mirage, and what is the cause? What is meant by concave and convex?

65. What must be the size of a glass in order to reflect a full-length image of a person?

*Ans.*—It must be one-half the person's height.

66. What kind of glasses will remedy long and short sightedness, and why?

*Ans.*—In many eyes, the lenses converge the rays so much as to cause the image of distant objects to be formed in front of the retina. Such people are near-sighted, and the failing is remedied by the use of concave spectacles. In other eyes, the lenses cause the object to fall back of the retina. Such persons are long-sighted, and this is benefited by the use of convex spectacles. The cause of near-sightedness is the too great converging power of the eye, while the cause of long-sightedness is their too feeble converging power.

*Query.*—Give a physiological description of the eye. Why does a blow on the head make one "see stars"? What is an optical instrument? Describe the opera-glass and camera-obscura. Who invented the telescope?

### 67. What is the solar spectrum?

*Ans.*—The dispersion of the white rays of the sun by their passage through a prism into the seven primary colors.

*NOTE.*—*Vibgyor*, mnemonic word.

### 68. What is electricity?

*Ans.*—*A form of energy* which manifests its presence in a variety of ways. These are generally arranged under two heads, viz., as a charge, and as a current.

*Query.*—What is known as to the real nature of electricity? Describe the Leyden Jar. Distinguish between *intensity* and *resistance*.

### 69. How may a body be electrified?

*Ans.*—In a variety of ways, but principally by friction.

*NOTES.*—There are two kinds of electrical discharges, viz. positive and negative. Electricities of the same kind repel each other; those of opposite kinds attract each other.

Glass rubbed with cat-skin becomes negatively electrified; but when rubbed with silk, positively electrified.

A body can be electrified by induction, or by contact.

A very great number of electrical machines have been devised, but the simplest form is known as the *electrophorous*.

*Query.*—If silk is rubbed with the hand, is it positively or negatively electrified? What are the five classes of electricity?

### 70. What are conductors of electricity?

*Ans.*—Bodies that offer no resistance to the passage of electricity through them are conductors. When they do.

they are non-conductors, or insulators. Copper is one of the best conductors; glass one of the best insulators. When a conductor is supported on a non-conductor, it is said to be *insulated*.

*Query*.—Which of the following are conductors? Wood, iron, air (moist and dry), water, silk and paper. What does current electricity produce?

#### 71. What is the theory of lightning rods?

*Ans.*—They protect the building on which they are placed, either by conducting the discharge to the earth, or by quietly neutralizing the electrified cloud by discharging opposite electricity into it.

*NOTE*.—There are two hypotheses of electricity: the single-fluid, first produced by Franklin; the double-fluid, offered by Symmer and DuFaye. The terms are self-explanatory.

*Query*.—Has nature provided any lightning-rods.

#### 72. What is an electroscope?

*Ans.*—It is an instrument used to determine the kind of electricity with which a body is charged.

#### 73. What are the effects produced by the electric discharge?

*Ans.*—Thermal, Physiological, Luminous, Mechanical, and Chemical.

#### 74. What is Voltaic electricity?

*Ans.*—That produced by chemical action.

*NOTE*.—Galvani (1796) ascribed the convulsive twitching of a frog's legs to a vital fluid. Volta ascribed these movements to the contact of two dissimilar metals, known as the "contact theory"; but afterwards demonstrated by his *Pile* that it was produced by chemical action.



*Ex.*—Lay a silver dollar on a sheet of zinc, and on the coin place a living snail. No sooner does the creature in moving about get partly off the dollar and on the zinc, than it receives a shock and recoils. The slime acts chemically on the zinc.

75. Name the sources of current electricity?

*Ans.*—Voltaic currents produced by chemical action; Thermo-electric produced by the action of heat; and Magneto-electric produced by the motion of magnets.

*NOTE.*—Frictional electricity is called *dynamic*; i. e. a force either at rest, or in motion. The velocity of electricity through a copper wire is estimated to be 233,000 miles per second. Describe Grove's and Bunsen's batteries.

76. Describe the Electric light.

*Ans.*—It is the vaporization of carbon electrodes (negative and positive) by means of combustion. There are two methods of electric lighting. One by incandescence of a poor conductor, as in Edison's mode; and the other by the electric arc between carbon points not in contact, as in Brush's method. The growth of the negative carbon at the expense of the positive, renders it necessary to adopt some means by which the carbons may be kept at a distance apart; for if they should get too far apart, the current at once ceases, and the light goes out, in which case the carbons must be brought together again, and slowly separated before the light appears. The carbons are kept apart by various forms of regulators, one of the simplest of which is called the *Jablochkoff Candle*. But such is the progress that has been made, that this contrivance is already considered behind the times. The great tower-light for light-house service is wonderful. It revolves slowly, sweeping a grand cone of light like a comet's tail along

the roofs of houses, sometimes bringing out the facade of a piece of antique architecture as if daylight were upon it, and again glittering like sunshine on the trees.

*Query.*—What is the voltaic or electric arc? Why is electricity called a force? Why will a polished globe remain electrified longer than one that is not?

### 77. What is Magnetism?

*Ans.*—It is the science that treats of the laws, properties, and phenomena of magnets. A magnet is a body that possesses the power of attracting and repelling other magnets. Magnets are either natural or artificial.

*Query.*—What are natural magnets called? From what did the magnet derive its name?

### 78. What is the law of magnets?

*Ans.*—The same as that of electrical attractions and repulsions. A magnet receives magnetism by *induction* (that is, by being brought into its magnetic field), and by contact.

*Query.*—Where is the magnetic pole in the northern hemisphere? By whom discovered?

### 79. How and by whom was the compass discovered?

*Ans.*—The compass is said to have been known to the Chinese, 1115 B. C.; but this seems to be a mistake. They had a machine which self-moved, pointed toward the south, and safely guided travelers by land or water.

Flavio Gioja, a navigator of Naples, introduced the suspension of the needle, as we have it now, in 1302. Until this time the needle was laid upon a couple of pieces of straw, or small split sticks in a vessel of water.

The variation of the compass was discovered by Columbus in 1492.

NOTE.—On certain lines upon the earth's surface, called lines of no variation, the needle points toward the poles; but the compass is liable to err in its indications from various causes, some of local, and others of a general nature. When the needle is disturbed, it oscillates until it gradually settles and points steadily to two points which are diametrically opposite to each other. As very little is known, comparatively speaking, of terrestrial magnetism, and its causes and effects, no hypothesis respecting the erratic movements of the needle can be received with safety, or considered satisfactory.

### 80. What is a magnetic needle?

ANS.—A magnetized bar of steel, supported at its centre of gravity on a point around which it is free to move. The end which points toward the north pole of the earth, is called the north pole of the needle.

NOTE.—The earth induces magnetism, for all iron bars standing vertically possess slight magnetic properties, and on being tested by the magnetic needle, will be found to possess north polarity in the end next to the ground, and south polarity in the other end.

Query.—What is meant by the declination and inclination of the needle? Where is the line of no-variation? What is magnetism by induction?

### 81. What is meant by induced electrical currents?

ANS.—A conductor conveying a current of electricity will induce a momentary current of electricity in a neighboring conductor, whenever the intensity of the current is increasing or diminishing.

Query.—What is a Galvanometer? How is the *Astatic needle* formed?

## 82. What is electro-metallurgy?

ANS.—It is the process of depositing one metal on another by the action of an electrical current.

NOTE.—Electro-plating is the suspension of the article to be plated in a solution of cupric sulphate, so as to make it the negative pole of a galvanic arrangement. If a metallic rod is attached to one end of a copper wire and a strip of zinc to the other end, and both ends are immersed in a solution of cupric sulphate, the rod will be plated with copper; but in practice an extraneous battery is used. A vessel is gold-lined by filling it with a solution of gold, suspending in it a slip of the same from the positive electrode, and then attaching the negative electrode to the vessel; while the current passing through the liquid causes it to bubble like soda-water, and in a few minutes, deposits a thin film of gold over the entire surface.

## 83. What is meant by the Electrolysis of water?

ANS.—If two platinum strips be made the electrodes of a voltaic battery, and plunged into water which has been rendered slightly acid for the purpose of increasing its conducting power, the current in passing through the water will decompose it, and hydrogen will be given off at the negative electrode, and oxygen at the positive.

## 84. What is the principle of the magnetic telegraph?

ANS.—It depends for its operation on the fact that a core of soft iron, surrounded by a coil of insulated wire, can be instantly magnetized and de-magnetized by completing or breaking an electric current, in the circuit of which the coil is placed.

Query.—What is electrotyping? What is gilding? Explain the difference between permanent-magnets and electro-magnets. Should electricity be employed as a curative agent?

NOTE.—A variety of dynamo-electric machines are now constructed, among which is the Gramme Machine. They are very successfully employed for the production of electricity for illumination and for electro-plating. The power possessed by electromagnets of retaining their magnetism only during the passage of the electrical current enables them to be employed in a great variety of electrical apparatus.

### 85. Name the late inventions.

ANS.—The Telephone, invented by Bell; the microphone by Prof. Hughes; the phonograph, an apparatus for recording the sounds of the voice, and reproducing them at any future time, invented by Edison.

### 86. Describe the Microphone.

ANS.—The microphone is a variety of telephone by means of which faint sounds, such as the steps of a fly over the board, can be heard at a great distance. The microphone is placed near the place where the sounds are originated, and connected by means of a carbon transmitter with a battery and telephone.

NOTE.—“The microphone is to the telephone what the microscope is to the telescope. The microphone enables us to hear minute sounds, and the telephone conveys sounds to a great distance; the microscope permits us to see minute objects, and the telescope larger and distant ones.”

### 87. What is the Teleradiophone?

ANS.—An ingenious adaptation of the photophone to telegraphy by M. Mercadier, the eminent French electrician.

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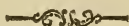
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What causes the white streaks on a plastered wall? How many horse-powers are required to raise 6 cu. ft. of water each minute to the height of 100 feet? Why can



not water be poured out of a full tumbler without running down the outside? A porter will carry 800 lbs; how many lbs. could he carry if he were placed half-way between the surface and the centre of the earth, and retained the same strength? Ans. 1600. I drop a pebble into a well, and hear it strike the bottom in exactly  $3\frac{1}{4}$  seconds. How deep is the well? A man weighing 160 lbs., and a boy 29 lbs., are teetering on a board. How near must the man sit to the rest to balance the boy? What is the greatest distance the human voice has ever been heard? Why is it darker from about half past one to about half past three than either before or after? If two nozzles, one of them half an inch in diameter, and the other one inch be attached to the same hose of an engine, which nozzle will throw the highest stream, vertically? Under what conditions might a cubic inch of lead weigh as much as a cubic foot of lead at a place above the earth's surface? Ans.—If a man falling from a tower were to hold a cubic inch of lead in one hand, and a cubic foot of lead in the other, there would be no difference in their weight, as neither would have any weight. Where would a cubic inch of lead weigh as much as a cubic foot of lead does weigh? Ans.—Let a cubic inch of lead weigh 1 oz.; then a cu. ft. would weigh 1728 oz.  $\therefore (x + 4000)^2 : 4000^2 :: 1728 : 1$ , from which  $x^2 + 8000x = 27,632,000,000$ , and  $x = 162276.8+$  miles above the earth's surface. Is it correct to say that  $50^\circ \text{C.}$  is twice as hot as  $25^\circ \text{C.}$ ? What is a Bell receiver? What is a Gram? What is the difference between gravity and gravitation? What is the *mechanical equivalent of heat*? If the base of the plane were 5 feet, its height 2 feet, and the man pushed parallel to the base, how much force must he exert to lift a barrel of flour? What causes the sweating of a pitcher? Suppose a body to be thrown upward with a velocity of 728

feet per second, to what height will it rise? How long does it take a ray from the moon to reach the earth, the moon's distance being 240,000 miles? A balloon was rising at the rate of 96 feet a second, when at the height of 300 feet a man fell out. How far did he fall if he fell to the earth? Ans.— $300 + 96^2 \div 64\frac{1}{2}$  feet = 443.25+ feet. *The indestructibility of matter* is the first great principle of modern science, and to Lavoisier belongs the glory of having first distinctly asserted it. What will be the time of vibration of a pendulum thirteen feet long? thirty feet long? If A and B carry between them, on a pole 9 feet long, a load of 150 pounds, how much will A bear when the load is 3 feet from him? 6 feet? What is Avogadro's Law? The distance of a man's hand from his elbow is 16 in. The biceps muscle is inserted in his fore arm 2 inches from the elbow. With what power must the muscle act to sustain a weight of 56 lbs. in the extended hand? The cannonading at Antwerp in 1832 was heard in the mines of Saxony, 320 miles distant. In how many seconds was the report transmitted? What is the spectroscope? Electricity as known to the Ancients. Thales, one of the seven wise men of Greece, who flourished 600 years B. C., is said to have discovered electricity in amber. Theophrastus, and Pliny, at a later date, speak of the attraction of amber for leaves and straws. Both Pliny and Aristotle were acquainted with the electrical properties of the torpedo, and we are informed that a freedman of the Emperor Tiberius cured himself of gout by the use of its shocks. Yet the ancients appear to have known nothing more than a few isolated facts connected with the subject; and as a science Electricity had no existence till the commencement of the seventeenth century. It is calculated that the light from the polar star requires  $3\frac{1}{2}$  years to reach the earth; what is its distance? Why do sea-shells give a murmuring noise when held to the ear? Why does lightning turn milk sour? What principle is embodied in the Ruhmkorff coil? What is a *thermo-pile*? What is the most diathermanous substance known?



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